K PLAN

ATERSHED PROTECTION AND FLOOD PREVENTION

TWIN-RUSH CREEK WATERSHED

Washington County, Indiana

OUR SOIL ★ OUR STRENGTH

WATERSHED WORK PLAN

TWIN-RUSH CREEK WATERSHED

Washington County, Indiana

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress, 68 Stat. 666) as amended.

Prepared by:

Washington County Soil and Water Conservation District

Twin-Rush Creek Conservancy District

City of Salem, Indiana

With Assistance by:

U. S. Department of Agriculture, Soil Conservation Service

U. S. Department of Agriculture, Forest Service

July 1964

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

ADDENDUM

Comparison Using 3-1/8% Interest

	Amortization of Install. Cost @ 3-1/8% for 50 yrs	Operation and Mainten.	Total
All Structural Measures	92,780	44,440	137,220

Total Annual Benefit from Table 6 229,086

Benefit Cost Ratio 1.67:1

TWIN-RUSH CREEK WATERSHED

SUMMARY OF THE PLAN

The Twin-Rush Creek Watershed is located in Washington County, in southeastern Indiana, about forty miles northwest of Louisville, Kentucky. The watershed occupies 28,099 acres (43.9 square miles) and contains 267 farms, which average about 105 acres in size. Approximately 26 farms will be directly benefited by the structural program.

Floodwaters from the steep headlands cause extensive damage to 2,152 acres of flood plain land in addition to 331 acres of flood plain land also affected by backwater from the East Fork of White River, making a total benefited area of 2,483 acres. Flood water damage to crops, pastures, land, roads, and ditches is heavy each year. About 5% of the flood plain also suffers from impaired drainage. Excessive runoff and erosion occurs on the uplands of the watershed. The shallow soil on the steep slopes has a low water holding capacity, and water supply is critical throughout the area.

The following works of improvement are to be installed within a five year period: (1) an accelerated land treatment program to enhance the present rate of land use adjustment to its safe use, and application of effective measures necessary for sustained agricultural production, (2) the installation of one multi-purpose structure for flood prevention and water supply, and two floodwater retarding structures; and (3) 1.1 miles of multi-purpose channel improvement for flood prevention and drainage, and 9.9 miles of flood prevention channel.

The proposed project will reduce flooding from an average of three times per year to once in a five year period during the cropping season. The average annual damage is $64,410. With the proposed project in effect, damages would be reduced 89%. The area presently flooded by the five year frequency storm is 1,829 acres. With the proposed project in effect, this storm will flood about 315 acres. A multi-purpose channel, designed for flood prevention and drainage, will provide adequate tile outlets for an area north of the main channel in Reach IV. Water supply for the City of Salem is incorporated in Structure #2 which will provide about three million gallons of water daily.

The total project installation cost is estimated to be $2,637,500.

The total installation cost for land treatment measures is estimated to be $305,620. The P.L. 566 cost for accelerated technical assistance of the land treatment program is $66,030. The other than P.L. 566 land treatment costs will be $239,590.

The total installation cost for structural measures is estimated to be $2,331,880. The P.L. 566 share of this cost is $1,168,590. This includes $1,162,560 allocated to flood prevention, and $6,030 to drainage. The other than P.L. 566 costs is $1,163,290 which includes $826,220 allocated construction cost for municipal water supply, $125,300 allocated installation services costs for municipal water supply, $3,430 allocated construction costs for drainage, $191,500 for land, easements and rights-of-way, and $16,840 for administration of contracts.

Maintenance of land treatment measures will be carried out by the land owners or farm operators involved. The Twin-Rush Creek Watershed Conservancy District will operate and maintain all structural measures

except Structure #2. This structure will be operated and maintained by the City of Salem. The estimated annual operation and maintenance cost is $44,440 for structural measures. This includes operation and maintenance of the pumping and piping facilities for municipal water supply of $36,000.

The Sponsoring Local Organizations are the Washington County Soil and Water Conservation District, the Twin-Rush Watershed Conservancy District, and the City of Salem, Indiana.

The estimated annual benefits from the proposed structural measures are $229,086, including: (1) damage reduction of $54,870, (2) changed land use benefit of $5,705, (3) more intensive use of present cropland of $10,232, (4) drainage benefits of $1,129, (5) local secondary benefits of $13,460, (6) incidental recreational benefits of $6,000, (7) water supply benefits of $124,500, (8) redevelopment benefits of $13,190.

The total annual benefits of $229,086 compared to the total annual costs--including Operation and Maintenance costs for structural measures--of $135,080, shows a benefit-cost ratio of 1.7 to 1.

DESCRIPTION OF THE WATERSHED

Physical Data

The Twin-Rush Creek Watershed is located in Washington County, which is in southeastern Indiana. The watershed is 28,099 acres, or 43.91 square miles in size and lies about six miles northwest of Salem, the county seat.

The tributaries, Rinkers Creek and Rush Creek, drain the southeastern part of the watershed. The stream then flows in a northwesterly direction, and is joined by Twin Creek which drains the southwestern area. The stream then flows northwesterly into the East Fork of White River about

5.3 miles downstream from the confluence of the Muscatatuck River with the East Fork of the White River. The watershed is about nine miles long by about five miles wide.

The watershed is characterized by narrow ridge tops, steep valley walls, and narrow flood plains. The area, known as the Norman Upland Physiographic Area, was not covered by glacial ice. Relatively thin residual soils mantle the bed rock. Capping the area, and present in sufficient thickness to be found on some of the lower valley walls, are limestones of lower-mid Mississippian Age (Harrodsburg limestone). Beneath this somewhat cavernous limestone is the Borden Shale and Sandstone formation. On the lower valley walls, particularly on the north and east sides of the valley, are old valley fill materials known as the Prospect Formation. These were deposited from local erosion sources during glacial ages when the streams were dammed by glacial debris at their lower extremeties. In the flood plains are from two to eight feet of recent alluvial depostis resting on lake bed silts and clays.

The steep slopes and shallow soils induce high runoff of rainfall. Water supply is critical since wells and springs do not provide enough to meet all needs. A few small ponds have been built in the watershed. The maximum watershed elevation near the southeast corner is about 960 feet above sea level while the elevation at the outlet into the East Fork of the White River is 488 feet above sea level.

Mean temperatures range from 34 degrees in January to 77 degrees in July. The recorded extremes are -32 degrees in February 1951 and 108 degrees in July of 1936. The average date of the last spring freeze is April 24, while that of the first fall freeze is October 15; providing

a 173 day freeze-free growing season. Mean annual precipitation is 44.3 inches with the more intense rains coming in May, June, and July. The minimum annual rainfall recorded at the Salem Weather Station, about six miles southeast of the watershed, is 29.4 inches in 1943, and the maximum is 62.1 in 1950.

Economic Data

The U. S. Census of Agriculture, 1959, for Washington County shows the average size farm to be 143 acres with an average value for land and buildings of $129 per acre. The price of the flood plain area, as estimated by the local people, is $250 to $300 per acre. General farming is practiced in the watershed with the major farm income derived from cash grain and the sale of livestock, with hogs, cattle, and poultry leading in that order.

Principal crops grown are corn, soybeans, small grain, and hay. There are approximately 267 farms in the watershed averaging in size about 105 acres. About five percent are tenant operated. Approximately 48% of the farm operators work off the farm with an estimated 85% of these having an off-farm income exceeding the value of agricultural products sold. According to the 1959 census for Washington County, 12% of the commercial farms have sales of less than $2500; 31%, less than $5000. This county has been designated an A.R.A. county. There are 54 cooperators and 21 basic farm plans within the watershed.

All land is privately owned. Few woodland areas exist with sufficient timber volume for an operable cut. Most of the upland slopes are wooded. The valley is relatively level, being quite narrow at the upper end, but gradually widening until it averages about a mile in width for the greater part of its length. Near the outlet the flood plain again narrows, limiting

its use. Pope and Haymond are the dominant bottomland soils.

Present land use conditions and future conditions, as anticipated after the project is installed, are shown as "Without Project"; future conditions are "With Project."

Land Use - Twin-Rush Creek Watershed

	Without Project			With Project		
	Floodpl.	Upland	Total	Floodpl.	Upland	Total
	- - -	Acres -	- - -	- - -	Acres -	- - -
Cropland	2,103	4,656	6,759	2,233	4,467	6,700
Grassland	24	4,943	4,967	24	5,440	5,464
Woodland	330	13,470	13,800	200	14,349	14,549
Other 1/	26	644	670	26	1,014	1,040
Idle		1,903	1,903		346	346
Total	2,483	25,616	28,099	2,483	25,616	28,099

1/ Includes farmsteads, roads, sediment pools, and structural sites.

There are no towns or villages within the watershed. A good county road system, a large proportion being asphalt paved surface, connects the area with Salem, the county seat, and Brownstown, Indiana. Salem is approximately six miles to the southeast which provides a market outlet and shipping point for the area.

WATERSHED PROBLEMS

Floodwater Damage

High intensity rainstorms result in rapid runoff from the steep hillsides. This results in high peaks, causing heavy damage to crops, roads, fence, and to the land. Floods occur on the average of three times per year during the cropping season. Lives are endangered during floods that

inundate the roads.

Frequent spring floods delay land preparation and planting on more than 2,000 acres of flood plain land. Replanting of crops, in many instances, is necessary. This often results in broken, uneven stands, increased cost of production, and reduced yields.

Fish and wildlife habitat is affected by the frequent overflow. Fish are forced out into the larger streams by the muddy waters and spawning areas are destroyed. The food supply of quail and other wildlife is limited due to floods. Areas that would provide cover and food during winter are covered by silt and debris.

The rampaging water, as described by a local resident, takes fence, wire, fence posts, and all that is in its path as it sweeps the valley. Floodwater damage to roads is severe in this watershed. Two of the major asphalt paved roads cross the flood plain. Floodwater damages include undercutting of the road, destruction of the road bed, paved surface, bridge abutments, and road culverts. Debris and gravel lodge in the road ditches requiring cleanout and reshaping. Damage to the road network interrupts school bus traffic carrying farm children to schools. It prevents farmers moving farm products to market without extra travel around damaged or flooded areas.

The flood of June 1960 caused more than $40,000 damage to crops, $12,000 to road and bridge, and $2,500 to fences and improvements. Debris that was washed out into the fields had to be removed before field operations could be resumed.

Frequent overflows interrupt farming operations and prevent full use of the flood plain acres. Drainage in some areas can not be done, or is

not feasible, due to overflow from floodwater. Yields could be increased and management practices carried out in the flood plain with flood protection. The total average annual floodwater damage is estimated to be $64,410, as shown in Table 5. The average annual floodwater damage to crops and pasture is $44,130. Average annual damage to the network of roads is estimated at $7,490. Other agricultural damage, mostly to farm fence, is estimated at $4,726 average annually.

Indirect damages include: disruption of traffic, depreciation in land values caused by frequent overflow, increased cost required to carry on normal operations during flood periods, and increased depreciation to farm machinery as a result of working over scour areas or handling dusty crops during harvest. Indirect damage is estimated to be 10% of total floodwater damages.

Sediment Damage

Sediment damage occurs on the watershed flood plains and in the stream channels. Flood plain sediments consist of very thin silt deposits over the entire flooded area, and narrow, sand deposits parallel to the channels. The thin silt deposits cause damages and are included in floodwater, and indirect damages. The sand deposits are narrow and the annual increment of damage is considered insufficient to warrant monetary evaluation.

Stream channels in the watershed are choked with gravel and lesser amounts of silt. This gravel comes from stream banks and channel bottoms, a source of supply closely related to channel maintenance. In some locations this gravel is removed for road metal, in which cases, the void produced, quickly fills in. Otherwise, the amount of gravel and silt in the

channels does not fluctuate except for the appearance or removal of debris blocks, such as trees and other stream debris. The aggravated flooding, brought about by debris-induced channel fill, is included in the overbank floodwater damages evaluated in this plan. These damages are considered inseparable.

Erosion Damage

Erosion in some form occurs throughout the watershed. Much of the ridge land has been cleared and subjected to severe sheet and gully erosion. A comparison of aerial photos made in 1940, and those made in 1954, clearly show that upland once in crops has, to a large extent, become idle or has reverted to less intensive use. The steeper land adjacent to the valley walls is severely eroded and gullied, while the flatter ridge tops are generally affected by sheet erosion only. The steep hillsides, mostly in timber, are also subjected to some sheet erosion and occasional gullies. The soils on these hillsides are shallow, can store little water, and are especially vulnerable to erosion. Woodland grazing, inadequate management practices, and insufficient replanting are largely responsible for excessive erosion on these slopes.

The lower slopes of the valley wall, adjacent to the flood plains, are often cropped with the flood plains. Severe sheet erosion and gullies are found on these slopes. Many crop fields on these slopes are unproductive and have been left idle in recent years. Upland erosion has not been evaluated as it will be largely controlled by land treatment measures.

Erosion, in the form of scour and stream bank cutting, is prevalent in the watershed. Stream bank erosion is of insufficient extent to warrant evaluation. Flood plain scour causes an estimated incremental

loss of productivity of from 38% to 50% on five acres annually. This is equivalent to about two acres being damaged 100% each year--100 acres that would be lost during a fifty year project life without controls. This amounts to $2,209 average annual damage from flood plain scour.

Problems Relating to Water Management

Most drainageways in the watershed flood plains are adequate to serve as drainage outlets. The frequency at which the agricultural land is flooded has discouraged the installation of proper drainage in areas that would profit by such installations. About 5% of the flood plain, most of which is in Reach IV, needs drainage outlet. The land treatment portion of this plan includes adequate arrangements to meet these drainage needs. Irrigation is not considered an important need at present.

The City of Salem obtains its water supply from an 80 acre, man-made lake in the Blue River Watershed. The present source of water is inadequate to meet their present needs. Water consumption is curtailed almost annually with a prolonged dry period. A new source of water in the way of surface water storage is needed to maintain and improve their present economic level, provide for expected increases in population, and to attract new business and industry.

There is a need for water for public recreation in this area. People within this area are not within driving range of adequate water oriented recreation. With expected population growth of Salem and surrounding area, water demand for recreation could become acute.

PROJECTS OF OTHER AGENCIES

Twin-Rush Creek is a tributary of the East Fork of the White River, and, as such, is part of the Wabash River Basin Study. This plan for

watershed protection will not affect or be affected by known, proposed or existing projects.

BASIS FOR PROJECT FORMULATION

The economy of the Twin-Rush Creek Watershed is primarily agriculture. Row crops, mostly corn and soybeans, are generally confined to the bottomland. Due to the topography of the watershed, there is very little upland suitable for cultivation. This places a considerably greater emphasis on flood protection of the flood plain. More than two thousand acres of flood plain land, with improvements valued at approximately one million dollars, are exposed to floods.

The following is from Water Supply Report - City of Salem, Indiana, by Fraps and Associates, Inc., Consulting Engineers, Indianapolis, Indiana, page 13.

"5.00 FUTURE WATER Supply Sources

5.01 General

Possible future water supply sources for the City, such as wells, natural springs, and impounded surface water, have been studied. Due to the geological formations and reports of experience in the vicinity of the City, the possibility of using wells as a future source of water supply is considered unsuitable. Water from Morris Spring is presently being used to supplement the primary City supply from Lake Salinda; however, the reliability of natural springs to produce a future primary source of the City water is doubtful. This leads to the possibility of using impounded surface water as a future source of water supply. The terrain surrounding the City lends itself to the construction of such surface water reservoirs."

These factors and the topography of the watershed influenced the selection of the three floodwater retarding structures with Structure #2 on Rinkers Creek designed to provide additional storage for municipal water. Structure #2, with a drainage area of 5,710 acres, is proposed to provide 3020 acre-feet of water. This would supply approximately three million gallons of water per day, as requested by the City of Salem, to provide for their present and anticipated future needs.

The sponsoring local organizations are in full accord with the recommendations of the city-employed consulting engineers in incorporating water storage in Structure #2 for Salem as an integral part of this project.

In addition to the project, as set forth in this plan, several variations were studied. Several alternate routes were considered for the channel location. Twelve structure sites were considered. The proposed project is the most practical at the least amount of cost to provide the benefits desired by the local people.

The sponsoring local organizations desire a five year level of protection on about 85% of the flood plain, with no more than one flood in five years during the cropping season. Channel improvement was necessary in the lower reaches to supplement the structure control in providing this level of protection. To provide a drainage outlet and flood control in Reach IV, an auxiliary ditch is proposed along the north side and paralleling the main channel.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

It is the belief of the project sponsors that the land treatment

program should be the first step in this watershed to bring about its protection, as well as, for flood prevention. At present, the land treatment measures applied and the rate of application are not sufficient to meet the desired results. There are 21 basic plans for soil and water conservation in the watershed and a total of 54 cooperators.

Land treatment measures to be applied on the watershed croplands will be (1) conservation cropping systems, (2) contour farming, (3) crop residue use, (4) diversions, (5) grass waterways, (6) minimum tillage, (7) grade stabilization structures, (8) ditch bank seeding, (9) surface drainage, (10) main and lateral drainage, and (11) tile drainage.

Necessary land treatment measures that will be applied on the watershed pasture lands are (1) pasture renovation, (2) pasture planting, (3) grassed waterways, (4) farm ponds, (5) grade stabilization structures, and (6) diversions.

A small portion of land in the watershed now devoted to idle and miscellaneous use will be utilized for wildlife habitat development. A total of 28 acres will be planted to feed and shelter producing plants for wildlife.

Woodland measures to reduce water and soil runoff will be (1) livestock exclusion, (2) improved forestry practices, (3) sustained yield practices, (4) cultural practices, and (5) forestation.

Structural Measures

The structural measures included in this plan, as shown on the project map, consist of two floodwater retarding structures, one multi-purpose structure, and 11 miles of channel improvement.

The three structures will be earth fill dams with principal spillways

of a reinforced concrete inlet and a reinforced concrete pipe conduit. Each structure has a two stage inlet to the principal spillway. The emergency spillways of each structure will be cut into Borden Shale. These structures are designed to temporarily detain 5242 acre-feet of floodwater. This amount of water is equivalent to 4.43 inches of runoff from the 22.21 square miles of drainage area above these structures. These three dams control 51% of the total watershed drainage area. Each structure is designed to detain the five year cropping season frequency runoff with moisture condition II$\frac{1}{2}$ between the low and high stage inlets.

A gated outlet will be provided to allow for drawdown of the reservoir or sediment pool. The normal stream flow can pass through the dam during construction. The dam can, therefore, be constructed in a more efficient manner and the borrow from the reservoir area can be more fully utilized. Also, the reservoir can be drained for health and safety reasons or to make repairs on the structure.

The geologic and soil conditions at the site appear satisfactory. Sufficient and suitable borrow material is available. Prior to design, detailed geologic investigations and soil mechanic analysis will be made for each site. Sediment storage requirements, as computed, are adequate for final design.

The two floodwater retarding structures (numbers 1 and 3) will contain a sediment pool capacity of 249 acre-feet. The total surface area of these two sediment pools will be approximately 40 acres. The sediment pools are designed for a 50 year life and would have favorable water holding potential. The sediment pool of Structure No. 1 will be about seven feet deep, and on Structure No. 3 it will be about ten feet deep.

The installation cost of the single purpose floodwater retarding structures is estimated to be $590,050. Figure 1 is a typical drawing of these structures. The cost distribution is given in Table 2. Design data for each structure is given in Table 3.

Multi-purpose Structure No. 2 will provide storage for flood prevention and municipal water supply. To supplement the existing water supply of the City of Salem, 3,020 acre-feet of water storage is planned in this structure. The surface area of the conservation pool will be about 210 acres. The total estimated installation cost of Structure No. 2 is $713,000. Details of the cost distribution and cost sharing may be found in Tables 2 and 2A. Design details are shown in Table 3.

A pumping station is planned in the reservoir near the dam with a pipe line to the treatment plant. The pumping station will consist of a concrete structure to house pumps and motors. It will include a ramp from the dam to the structure and all necessary appurtenances. Pumps and pipe line will be installed to provide an initial capacity of one million gallons per day. The installation of additional pumps and pipe line will be made as needed to bring the capacity up to a maximum of three million gallons per day. The initial installation of pipe line will consist of approximately 18,800 feet of 10 inch diameter pipe.

The pumping station and pipeline are estimated to cost $278,000 initially. The cost for providing an additional two million gallons per day is estimated to be $440,000. It is estimated that the additional capacity will be needed 15 years after the project is installed. The total installation cost of these facilities, as shown in Table 2, is $626,020.

The channel design is based on the five year frequency cropping season flow. The planned channel in Reaches III, IV, and IX will carry the design flow within banks. The channel improvement in Reach I will be sufficient to provide an outlet. The planned channel in Reach II will carry the design flow with minor flooding. The design flow will be within banks at the upper end of Reach II. Reach V, as designed, will carry the design flow within the channel banks. However, there may be isolated spots where the planned channel may not completely contain the design flow.

The lower portion of the existing channel in Reach I will be cleared of woody growth, brush, and debris; and the banks will be seeded as needed. Some excavation will be accomplished following the existing channel in the upper part of Reach I. The channel will be straightened considerably in Reaches II, III, and the lower quarter of Reach IV. Minor straightening is planned in the rest of Reach IV. The lower part of Reach V will follow the existing channel and will be cleared, snagged, and the banks will be shaped to reduce the roughness factor.

The upper portion of Reach V will be cleared, snagged and seeded. All of the channel improvement except Reach IX is for flood prevention only.

Reach IX is a multi-purpose flood prevention and drainage channel. This channel is designed to carry the five year frequency cropping season flow. It will have adequate depth for drainage. The channel in Reach IX will drain the low area along the north side of the flood plain and intercept the runoff from the hills along the north side of the valley.

The design features of the channel are given in Table 3A. Figure 2

Conservation Service, Engineering Design Unit, located at Indianapolis, Indiana.

Installation services include engineering services and other services. Engineering services include all direct P.L. 566 and other costs for the services of engineers and geologists used in designing and installing the structural measures. Examples of engineering services are construction surveys and investigations, soil and foundation drilling and testing, necessary inspection, installation assistance, preparation of plans and specifications, and similar services in carrying out construction. Other services include all overhead costs for structural measures, as well as, direct costs for installation service provided by other than engineers and geologists.

Administration of contracts includes all local costs for administration, legal, and clerical services incurred by the contracting local organization in carrying out contracts.

Land, easements, and rights-of-way include the following costs:

A. All expenditures made in acquiring land, easements, and rights-of-way, or their value, as estimated by the local organization and the Service.

B. All expenditures for the closing, relocation, or raising of private or county roads, or permission to flood these roads.

C. All expenditures for purchasing, removing, or relocating houses, buildings or other improvements, or permission to flood these facilities.

D. All expenditures for relocating or removing utility lines.

E. Relocation or reconstruction of fences.

F. Replacement or changes to bridges other than underpinning.

Land rights needed for floodwater retarding Structure No. 1 include an area of about 105 acres and two corn cribs. The sediment pool will require about 26 acres. The flood pool will require an additional 66 acres. The dam and emergency spillway site will require about seven acres. Some of the borrow will come from the permanent pool and some from the flood pool. An additional six acres from the valley sides above the flood pool is included in the 105 acres total for borrow material only.

Multi-purpose Structure No. 2 will require about 290 acres for the flood pool, of which approximately 210 acres will be in the conservation pool. The dam site and emergency spillway will require an additional 17 acres. One vacant house, three barns, and two corn cribs will be removed. Also, roads to areas isolated by the dam and reservoir, may be needed. The county road in the flood plain will be closed.

Floodwater retarding Structure No. 3 will necessitate the closing of the road following the valley across which the dam will be built. An alternate route exists of approximately the same distance to Salem. The utility line at the dam site will have to be moved. A barn at the dam site will have to be removed. The estimated 104 acres required for this structure includes 14 acres in the sediment pool, an additional 50 acres for the flood pool, 15 acres for the dam site and emergency spillway, and 25 acres on the ridge top adjacent to the site which are included for borrow material.

The land rights for channel improvement include an area along the proposed channel for construction, for spreading of the spoil, and for maintenance. In addition, areas for ingress and egress to the channel

will be needed. An estimated 162 acres of cropland and pasture will be needed during construction for room to work and spreading of the spoil. In addition, some areas of presently wooded flood plain will be cleared and used during construction. The area needed permantly for the channel and for maintenance is about 94 acres. The present land use of the 94 acres is woods, pasture, and cropland. The area for the new channel, which is currently taken up by the existing one, was not included in the easement area.

The cost of constructing a bridge near the upper end of Reach III across the new channel is also included in the land easements and rights-of-way figure. Approximately one half mile of road will be relocated with a bridge over Twin Creek (Reach VIII) near the lower end of Reach IV. It was determined by the local watershed leaders and county road officials that this bridge and road relocation would be more desirable than constructing a larger bridge over the new channel of Rush Creek.

The cost of multi-purpose Structure No. 2 is allocated by the "Use of Facilities Method." This method provides for the cost to be allocated to a purpose in direct proportion to the storage volume available for that purpose. Structure No. 2 is allocated 46.3% to flood prevention and 53.7% to municipal water supply. The cost of $288,900, which is the construction and installation services cost allocated to flood prevention, will be borne by P.L. 566 funds. The cost of construction and installation services allocated to municipal water supply, all land, easements, and rights-of-way costs, and all administration of contract costs will be borne by local funds.

In addition, all specific costs for municipal water supply will be

borne by local funds. Specific costs included in the project are the cost of the pumping station at the reservoir and the pipe line to the treatment plant. These costs were determined from the Water Supply Report to the City of Salem by Fraps and Associates, Inc., Consulting Engineers. The construction cost of the raw water pumping and piping facilities include the initial cost of construction plus the cost of installing additional pumps and pipeline discounted 15 years at 3% interest. The total cost to the local organization on Structure No. 2 is estimated to be $424,100, and specific cost to municipal water supply is $626,020. A summary of the cost sharing and cost allocation is shown in Table 2A.

The cost of Reach IX of channel improvement is allocated by the "Second Alternate Method," as described on page 1132.1 of the Watershed Protection Handbook. The cost of Reach IX allocated to flood prevention, is $20,170 or 67.2%, and to drainage is $9,860 or 32.8%, as shown in Table 2A. The P.L. 566 share allocated to drainage will be $6,030, and the local share will be $3,830.

An estimated schedule of Federal and non-Federal obligations for the installation of the structural measures by fiscal year is tabulated as follows:

Fiscal Year	P.L. 566	Other	Total
1st	$ 34,000	$163,000	$197,000
2nd	280,500	619,350	899,850
3rd	167,000	14,500	181,500
4th	416,000	77,550	493,550
5th	271,090	288,890 1/	559,980
	1,168,590	1,163,290	2,331,880

1/ Includes $282,420 present value of future installations to municipal water supply.

Non-Project Costs

All non-project costs incurred must be borne by the sponsoring local organizations. These costs are additional items not included in benefit-cost, cost allocation, or cost sharing computations.

Non-project costs include all additional costs resulting from changes of, or additions to, project works of improvement for non-project purposes or maintenances such as (1) altering a structure to permit its use as a roadway, (2) distributing and leveling spoil or disposing of excavated material primarily to improve land, (3) filling abandoned channels or depressed areas outside of the right-of-way or to relieve local organizations of the responsibility of acquiring the necessary right-of-way, (4) constructing maintenance roads and associated culverts, (5) relocating or modifying planned works of improvement for the convenience of the sponsoring local organizations.

Non-project costs also include costs for land, construction, surveying, engineering and legal services connected with the installation of water treatment and storage facilities, and treated water distribution systems for municipal water supply. The cost of operation and maintenance of facilities other than the measures included in the project are non-project costs and, therefore, are not shown in this plan.

EFFECTS OF WORKS OF IMPROVEMENT

The works of improvement, as outlined in this plan, will reduce flooding from an average of three times per year to once in a five year period with the exception of 315 acres in Reaches II, IV, and V, that will have

a three year level of protection. Floodwater damages would be reduced approximately 89% in all reaches except Reach I which was not evaluated. Improvements to the agricultural land within the flood plain will be possible with reduction of the flood hazard and improved drainage outlets.

Crop and pasture damage of $40,000, road and bridge damage of $12,000, and damage to fence and improvements of $2,500, caused by the June 1960 flood would be reduced with project to $4,500, $1,900, and $300 respectively.

The 50 year frequency storm, in present condition, floods 2,483 acres. With project, this size storm will flood 1,230 acres, a reduction of 50%. Presently, the five year frequency storm floods 1,829 acres. After project installation, this size storm will flood about 315 acres.

The reduction of the flood hazard during the cropping season of April through November will permit needed improvements and a shift of crops that are now being grown on the upland, to Class I and II land. This will reduce erosion and provide for better land use. Crop yields within the flood plain can be increased with present day managerial practices that are being applied on flood free land within this area. A total of 1,251 crop acres will be used more intensively with project conditions. In Reach IV, 130 acres of woodland will be cleared for cropland. Estimates indicate that there will be no increase in the total acreage of allotted crops within the watershed as a result of this project.

The total flood plain of 2,483 acres will benefit from adequate or improved drainage systems that now can be installed with project. The existing tile drainage will operate more effectively in areas where it is now inoperative due to frequent flooding.

It is estimated that about 26 farms in the flood plain will be directly

benefited by the structural program. There are approximately 1,070 people within the watershed who will receive some type of benefit from this project.

The total average annual damage from floodwater and erosion, as determined by this study, amounts to $64,410. The over-all reduction by the proposed project, including the land treatment measures, is 89% of all damages.

Floodwater damage to crop and pasture is $44,130, which represents 68% of the total floodwater damages. With project, this amount will be reduced to $4,700--a reduction of 89%. Other agricultural damage, estimated at $4,726, will be reduced to $485 with project.

Non-agricultural type of damage, mainly to roads, amounts to $7,490. A high level of protection to this facility is provided by the proposed measures. As evaluated at each road crossing, the flood stages at these points are reduced below the elevation that major damage occurs.

Drainage benefits will accrue to the multiple purpose channel designed for flood prevention and drainage. This proposed channel will intercept floodwater and provide a drainage outlet for over 100 acres of low land in Reach IV. This land will produce over 100 bushels of corn per acre with adequate drainage. Five farm units will benefit from this measure.

Municipal water supply included in Structure #2 will supply over three million gallons per day. This will serve the present and projected needs of the City of Salem with a present population of over 5,000 people. Many local farmers in the county also depend upon Salem for water. Water is hauled by trucks for filling cisterns and livestock watering tanks. During the 1963 drought, this supply was cut off, and water had to be hauled from

Louisville, Kentucky, and other distant points to meet this rural need. This proposed storage will assure these farmers of adequate water available at a distance that is profitable to haul for their domestic use.

Incidental public recreation associated with Structure #2 development and lake of 210 acres will be improved as facilities are developed by the City for boating, fishing, and later, swimming. It is estimated that this body of water will be used by over 15,000 people per year. This development will have public access and will be used by the general public. Incidental recreation benefits to sediment pools of the two floodwater retarding structures would be mostly from fishing. These sediment pools would provide several visitor days of use per year to the local community.

Fish and Wildlife

The Biologist of the Soil Conservation Service and the Watershed Planning Party conducted reconnaissance studies in the watershed to determine the effect the proposed improvements would have on fish and wildlife.

The findings were that both gains and losses would result with the proposed plan in operation. Stream channel alterations would temporarily disrupt stream fishing. Total fish habitat would be greatly increased by the multi-purpose floodwater retarding structure and farm pond construction. Water quality would also be greatly improved.

A gain in wildlife is anticipated by the improvement of wildlife habitat in the watershed. This will be especially applicable to the following species of wildlife: deer, doves, squirrels, rabbits, quail, songbirds, and waterfowl.

All impounded water, including the sediment pools, will be stocked with fish. Safe trees will be left to shade stream fishing where possible

in the lower reaches of the stream.

PROJECT BENEFITS

The total annual benefits of the proposed project, as shown in Table 6, are estimated at $229,086, including: (1) damage reduction due to structural measures of $54,870, (2) changed land use benefit $5,705, (3) benefits from more intensive use of present cropland of $10,232, (4) drainage benefit of $1,129, (5) local secondary benefit of $13,460, (6) incidental recreation benefit of $6,000, (7) water supply benefit of $124,500, and (8) redevelopment benefit of $13,190.

The accrual of secondary benefits within the immediate zone of influence of the project was based on ten percent of the direct primary benefits. These benefits would be to processing, transporting, and marketing of those goods and services brought about by the project. Also, the supplying of additional materials and services provides a local secondary benefit. These benefits are increased net return to suppliers of farm equipment and materials required to make possible the net returns which stem from the project facilities. These were estimated to be ten percent of the increased cost of achieving increased production.

Redevelopment benefits would result from income provided in the labor used in construction, operation and maintenance, and other services created by the project measures. As indicated by the City of Salem, the addition of an adequate, and projected needs water supply, will open new areas northwest of the city to industrial and residential construction. This would add new jobs and income to many unemployed or under-employed residents of this area.

Intangible benefits not measured in monetary terms will accrue with

the installation of this project. These include benefits derived from the installation of land treatment measures by those farmers which exceed the cost of applying such measures, and a benefit to the community in a way of providing a more stable farm income to low income farmers who cannot compete with larger, more efficient types of farms. With project, these low income farms with sales of less than $2500 will be able to diversify their operations by more efficient use of their flood plain land.

COMPARISON OF BENEFITS AND COSTS

Benefit and cost comparison for the single unit of evaluation is shown in Table 6. Based on primary structural measure benefits of $215,626, and an average annual cost of $135,080, the benefit-cost ratio is 1.6 to 1. An additional benefit-cost ratio, computed by combining local secondary benefits of $13,460 with primary benefits, shows a benefit-cost ratio of 1.7 to 1.

PROJECT INSTALLATION

Land Treatment Measures

Land treatment measures, as determined necessary by soil survey land capability classifications, will be applied to protect the watershed farm lands from excessive runoff, soil loss and impaired drainage. These measures will be outlined in basic farm plans which are the instruments by which farm owners and operators agree to properly manage their lands. The Soil Conservation Service will provide technical assistance for developing these plans and applying the measures.

The Indiana Department of Conservation, in cooperation with the U. S. Forest Service will furnish technical assistance for the forestry measures included in this plan.

The Washington County Soil and Water Conservation District will have the responsibility for the application of the land treatment measures. Work priorities will be established, the necessary technical assistance will be provided, and follow-up contacts will be made under the supervision of the district supervisors.

The Washington County Soil and Water Conservation District will obtain agreements to install the needed land treatment measures on not less than 50% of the land above the proposed floodwater retarding and multi-purpose structures prior to or concurrently with the construction of the structural works of improvement.

Structural Measures

All works of improvement will be installed during a five year period. The first year may be utilized for securing easements and completing construction plans and specifications on contracts to be let the second year. In order to realize the most benefit from the structural measures, they will be installed in the following sequence:

1. Multi-purpose Structure No. 2, including pumping station and pipe line to filtering plant
2. Floodwater retarding Structure No. 1
3. Floodwater retarding Structure No. 3
4. All channel improvement

The City of Salem now has the financial ability or can readily initiate action to make financial arrangements for providing that portion of the construction costs and installation services of Structure No. 2 allocated to municipal water supply, as well as, the specific cost to municipal water supply. The city has the right of eminent domain

and will be responsible for securing the land, easements and rights-of-way and for administering the contracts for Structure No. 2.

The Twin-Rush Creek Watershed Conservancy District is a sponsoring local organization, qualified under state law to carry out the works of improvement, as outlined in this plan. The conservancy district has the power of eminent domain and taxation, as provided by the Indiana Conservancy Act. The conservancy district will be responsible for securing land, easements, and rights-of-way, and to administer the contracts for the installation of all works of improvement except as previously stated for Structure No. 2. That portion of the construction cost to be provided from other funds for Reach IX of the channel, will be provided through the conservancy district.

The portion of the construction costs and installation services shown in Table 2, under P.L. 566 funds, will be provided from these funds through the Soil Conservation Service. Engineering service allocated to flood prevention and agricultural water management, in the form of surveys, investigations, construction plans and specifications, and construction inspection for the channels and structures, will be provided by the Soil Conservation Service.

As sponsors, the Washington County Soil and Water Conservation District will provide such assistance and guidance as necessary to expedite coordination between the land treatment and the structural features of this plan.

The Indiana Flood Control and Water Resources Commission, in accordance with state laws and regulations, will review for approval, the plans and specifications for the works of improvement to be constructed. These laws and regulations are embodied in the Indiana Conservancy Act.

FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the works of improvement on the lands in this watershed, as described in this work plan, will be provided under the authority of the Watershed Protection and Flood Prevention Act (P.L. 566, 83rd Congress, 68 Stat. 666). However, Federal financial assistance is contingent on the appropriation of funds to carry out this plan.

A.C.P. cost sharing is available for the installation of land treatment measures and special funds may be provided for this purpose. Farm owners and operators will provide the funds for their share of the installation of the land treatment measures included in this plan.

The Twin-Rush Creek Watershed Conservancy District has been established by the local court. This will be the legal means by which the local people will carry out their responsibilities in the installation of the proposed works of improvement. The sponsoring local organizations have analyzed their financial needs in consideration of the scheduled installation of the works of improvement and have negotiated with the State Director of F.H.A. to establish a line of credit so funds will be available when needed.

The conservancy district will provide for the financial obligations of other than P.L. 566 funds estimated at $113,170 on floodwater retarding structures 1, 3, and channel improvement, including the local cost share of the allocated cost of drainage on Reach IX. The City of Salem will provide for the other than P.L. 566 funds on Structure No. 2, estimated at $424,100 and specific cost of $626,020. Land Easements and rights-of-way for this multiple purpose structure will be negotiated by the city.

Other required facilities of which the entire cost is chargeable to the water supply, include a water treatment plant and transmission water lines. These items will be paid for by the City of Salem. The estimated cost of these facilities is not included as a part of this plan.

Table I shows the area of land programmed for treatment, including the cost of applying the land treatment measures and the cost of technical assistance. The total estimated cost of the land treatment measures is $305,620. This includes $212,530 for measure installations and $93,090 for technical assistance. The landowners and operators will bear the $212,530 cost of installing the land treatment measures. It is expected that Agriculture Conservation Program cost-sharing will be available to qualified landowners for installing these measures.

Under Soil Conservation Service, the technical assistance is estimated at $59,350, of which $52,000 will be provided under authority of P.L. 566 and $7,350 will be available through the regular P.L. 46 going program.

The technical assistance for installing forestry measures will cost $33,740, of which $14,030 will be provided under authority of P.L. 566, $13,240 will be provided by the Indiana Department of Conservation, Division of Forestry, and $6,470 will be provided by the Indiana Department of Conservation in cooperation with the U. S. Forest Service through the going Cooperative Forest Management Program. The State will begin cooperations with its funds at the earliest possible date. However, it it does not have funds available for cost-sharing during the first year of installation, the forestry technical assistance during this period will be furnished wholly from P.L. 566 funds.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

The maintenance of land treatment measures is incorporated into agreements between land owners and operators and the Washington County Soil and Water Conservation District. The land owners and operators will carry out the maintenance with technical assistance from the Soil Conservation Service or the Indiana Division of Forestry in cooperation with the United States Forest Service under the Cooperative Forest Management Program.

Structural Measures

The Twin-Rush Creek Watershed Conservancy District will be responsible for the operation and maintenance of all the planned structural measures except Structure No. 2. The City of Salem will be responsible for the operation and maintenance of Structure No. 2. The channel in the benefited area, where no channel improvement is planned, will be maintained by the conservancy district in such a manner to realize the full benefits from the project. The cost of operation and maintenance work is estimated to be $1,735 annually for the three structures, of which $800 is for Structure No. 2, and $6,705 annually for the channels. This amounts to an annual total of $8,440 for operation and maintenance.

The operation and maintenance for the pumping station and raw water pipe line is estimated to be $20,000 annually for the installation providing one million gallons per day. An additional $16,000 annually is needed for operation and maintenance of the pumping and piping facilities to be installed 15 years hence to provide a total of three million gallons per day. The present value of the total annual operation and maintenance is

$36,000 for municipal water. These estimates are derived from information contained in the report by Fraps and Associates, Consulting Engineers to the City of Salem.

Inspection of the structural measures will be made annually and as needed after severe storms. The team making these inspections will consist of, at least, a representative of the conservancy district, a representative of the Soil Conservation Service; and for Structure No. 2, a representative of the City of Salem. A record of the inspection will be kept in the file of the conservancy district and will be available for authorized inspection.

Land owners, on whose land the structural works are located, may enter into agreements with the conservancy district for maintenance. These agreements will specify the maintenance land owners are to perform, such as (1) reseeding and fertilizing of embankments and channel banks, (2) isolated channel spraying or mowing, and (3) removal of minor debris blocks in the channels and at the entrance to spillways. It is estimated that this work will amount to about 25% of the total operation and maintenance cost.

Other operation and maintenance work requiring special equipment, or otherwise beyond the capacity of the landowner, will be carried out by the conservancy district by force account or contract. This work includes such items as: (1) repairing of major damage to structure embankments and to spillways, (2) major streambank spraying, and (3) major repair or cleanout of stream channel bottom and banks.

An operation and maintenance agreement for each structural measure

will be executed between the conservancy district and the Soil Conservation Service prior to the issuance of an invitation to bid on construction. In the case of Structure No. 2, the agreement will also include the City of Salem.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Twin-Rush Creek Watershed, Indiana

Installation Cost Item	No. to be Applied		Estimated Cost (Dollars)1/		
	Unit	Non-Federal Land	P.L. 566 Non-Federal Land	Other Non-Federal Land	Total
LAND TREATMENT FOR WATERSHED PROTECTION					
Soil Conservation Service					
Cropland	Acre	6,759		74,420	74,420
Grassland	Acre	4,967		72,570	72,570
Idle & Miscellaneous	Acre	2,573		900	900
Technical Assistance			52,000	7,350	59,350
SCS Subtotal			52,000	155,240	207,240
Forest Service					
Woodland	Acre	8,200		64,640	64,640
Technical Assistance			14,030	19,710	33,740
FS Subtotal			14,030	84,350	98,380
TOTAL LAND TREATMENT			66,030	239,590	305,620

1/ Price base 1963

July 1964

TABLE 1 - ESTIMATED PROJECT INSTALLATION COST
Twin-Rush Creek Watershed, Indiana

Installation Cost Item	No. to be Applied		Estimated Cost (Dollars) 1/		
	Unit	Non-Federal Land	P.L. 566 Non-Federal Land	Non-Federal Land	Total
STRUCTURAL MEASURES					
Construction Cost					
Soil Conservation Service					
F.W.R. Structures	No.	2	444,000		444,000
Multi-Purpose Structure	No.	1	229,200	265,800	495,000
Pumping Station & Pipe Lines				560,420	560,420
F.P. Channel Improvement	Miles	9.9	214,740		214,740
Multi-Purpose Chan. Improvement	Miles	1.1	17,450	3,430	20,880
Subtotal Construction			905,390	829,650	1,735,040
Installation Services					
Soil Conservation Service					
Engineering Services			201,300	69,300	270,600
Specific Cost to Mun. Wat. Supply				56,000	56,000
Other			61,900		61,900
Subtotal Installation Services			263,200	125,300	388,500
Other Costs					
Land Easements & R/W				191,500	191,500
Adm. of Contracts				16,840	16,840
Subtotal Other Costs				208,340	208,340
TOTAL STRUCTURAL MEASURES			1,168,590	1,163,290	2,331,880
TOTAL PROJECT			1,234,620	1,402,880	2,637,500
SUMMARY					
Subtotal SCS			1,220,590	1,318,530	2,539,120
Subtotal FS			14,030	84,350	98,380
TOTAL PROJECT			1,234,620	1,402,880	2,637,500

1/ Price base 1963

July 1964

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(At Time of Work Plan Preparation)
Twin-Rush Creek Watershed, Indiana

Measures	Unit	Applied To Date	Total Cost (Dollars)
LAND TREATMENT			
Cons. Crop System	Acres	1,271	1,270
Contour Farming	Acres	600	120
Wildlife Habitat Dev.	Acres	15	480
Crop Residue Utilization	Acres	916	920
Diversions	Feet	9,256	930
Ponds	No.	13	5,200
Structures (Stabilization)	No.	2	450
Grass Waterways	Acres	5.2	690
Pasture Planting	Acres	241	12,050
Pasture Renovation	Acres	242	12,100
Drainage Surface Field	Feet	2,550	260
Tile	Feet	47,329	10,410
Main & Laterals	Feet	8,490	10,190
Fire Control	Acres	13,800	12,810
Livestock Exclusion	Acres	11,685	46,740
Improved Forestry Practices	Acres	3,225	3,220
Sustained Yield Practices	Acres	47	470
Forestation	Acres	24	840
Basic Plans	No.	21	
Cooperators	No.	54	
			119,150

July 1964

TABLE 2 - ESTIMATED STRUCTURE COST DISTRIBUTION
Twin-Rush Creek Watershed, Indiana
(Dollars) 1/

Measure	Structure Number	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds				Total Other	Total Inst. Cost
		Construction	Install. Engrg.	Services Other	Total P.L. 566	Construct.	Inst. Serv.	Adm. of Contr.	L.E. & R/W		
Structure	1	114,000	30,000	8,000	152,000			1,500	15,250	16,750	168,750
	2	229,200	42,600	17,100	288,900	265,800	69,300	5,000	84,000	424,100	713,000
Pump. Sta. & Pipe Lines						560,420 2/	56,000	5,600	4,000	626,020	626,020
	3	330,000	58,000	18,000	406,000			2,300	13,000	15,300	421,300
Subtotal Structures		673,200	130,600	43,100	846,900	826,220	125,300	14,400	116,250	1,082,170	1,929,070
Channel Improvement, F.P.											
Reach No.	I	24,240	7,270	1,940	33,450			240	1,450	1,690	35,140
	II	78,600	23,560	6,290	108,450			790	8,400	9,190	117,640
	III	63,600	19,100	5,100	87,800			700	33,600	34,300	122,100
	IV	37,900	11,400	3,000	52,300			400	30,500	30,900	83,200
	V	10,400	3,100	800	14,300			100	300	400	14,700
Subtotal F.P. Channel		214,740	64,430	17,130	296,300			2,230	74,250	76,480	372,780
F.P. & Drainage Reach No.	IX	17,450	6,270	1,670	25,390	3,430		210	1,000	4,640	30,030
TOTAL		905,390	201,300	61,900	1,168,590	829,650	125,300	16,840	191,500	1,163,290	2,331,880

1/ Price base 1963

2/ Including $278,000 initial cost of pumping station and pipeline to treatment plant and $282,420 ($440,000 discounted 15 years) for adding 2 MGPD to pumping and piping of raw water to the treatment plant.

July 1964

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY
Twin-Rush Creek Watershed, Indiana

(Dollars) 1/

Item	Purpose			
	Flood Prevention	Drainage	Municipal Water	Total
Single Purpose F.W.R. Structures & Chan. Improvement	962,830			962,830
Multi-Purpose Str. No. 2	330,120		382,880	713,000
Pump. Sta. & Pipe Line			626,020	626,020
Reach No. IX	20,170	9,860		30,030
TOTAL	1,313,120	9,860	1,008,900	2,331,880
P.L. 566	1,162,560	6,030	-	1,168,590
Other	150,560	3,830	1,008,900	1,163,290
TOTAL	1,313,120	9,860	1,008,900	2,331,880

1/ Price base 1963 July 1964

TABLE 3 - STRUCTURE DATA
Twin-Rush Creek Watershed, Indiana

Item	Unit	Structure Number 1	2	3	Total
Drainage Area	Sq.Mi.	8.60	8.92	4.69	22.21
Storage Capacity					
Sediment	Ac.Ft.	151	167	98	416
Floodwater	Ac.Ft.	1119	2433	1690	5242
Water Supply	Ac.Ft.	-	3020	-	3020
Total	Ac.Ft.	1270	5620	1788	8678
Between High and Low Stages	Ac.Ft.	505	523	275	1303
Surface Area					
Sediment Pool	Ac.	26	80	14	120
Floodwater Pool	Ac.	92	290	64	526
Water Supply Pool	Ac.	-	210	-	210
Volume of Fill	Cu.Yds.	139,000	600,000	329,000	1,068,000
Elevation Top of Dam	Ft.	572.0	616.5	656.5	
Maximum Height of Dam	Ft.	38.5	63.5	75.5	
Emergency Spillway					
Crest Elevation	Ft.	560.0 2/	600.0 2/	636.5 2/	
Bottom Width	Ft.	40	30	40	
Type		shale 3/	shale 3/	shale 3/	
Percent Chance of Use		2 -	2 -	1 -	
Ave. Curve No. - Cond. II		75	75	75	
Emergency Spillway Hydrograph					
Storm Rainfall (6-hr.)	In.	4.47	7.10	10.12	
Storm Runoff	In.	2.02	4.24	6.98	
Velocity of Flow (V_c) 1/	Ft/Sec.	0	0	2.3	
Discharge Rate 1/	c.f.s.	0	0	16	
Max. W/S Elev. 1/	Ft.	557.6	598.6	636.9	
Freeboard Hydrograph					
Storm Rainfall (6-hr.)	In.	11.28	23.61	26.24	
Storm Runoff	In.	8.08	20.03	22.62	
Velocity of Flow (V_c) 1/	Ft/Sec.	16.4	18.7	21.2	
Discharge Rate 1/	c.f.s.	5360	5985	11,900	
Max. W/S Elev. 1/	Ft.	572.0	616.25	656.5	
Principal Spillway					
Capacity-Low Stage	c.f.s.	86	89	46	
Capacity-High Stage	c.f.s.	250	335	100	
Storm Rainfall	In.	4.09	4.09	7.09	
Storm Duration	Hr.	6	6	48	
Runoff Curve No.		83	83	75	
Storm Runoff	In.	2.36	2.36	4.23	
Capacity Equivalents					
Sediment Volume	In.	0.32	0.35	0.37	
Detention Volume	In.	2.44	5.11	6.75	
Spillway Storage	In.	2.89	12.25	6.63	
Class of Structure		a	b	c	

1/ Maximum during passage of hydrograph
2/ Raised above minimum due to rock excavation
3/ Borden shale--dense & relatively impervious

July 1964

TABLE 3A - STRUCTURE DATA
CHANNELS
Twin-Rush Creek Watershed, Indiana

Channel Designation	Sta. No. for Reach Sta.	to Sta.	Watershed Area 1/ (Sq.Mi.)	Purpose 2/	Required Channel Capacity (c.f.s.)	"n"	Grade (%)	Ave. Bottom Width (Ft.)	Ave. Side Slope	Ave. Depth (Ft.)	Ave. Channel Area (Sq.Ft.)	Ave. Veloc. (Ft/Sec)	Volume of Excavation (1000 CuYd)
Reach I	800	740	21.2	F.P.	1675	.05	.04						0 3/
	740	690	21.2	F.P.	1675	.035	.04	30	2:1	10.6	540	3.10	18.5
Reach II	690	560	19.0	F.P.	1675	.035	.04	30	2:1	10.6	540	3.10	170
Reach III	560	465	15.5	F.P.	1650	.035	.09	30	2:1	8.5	400	4.13	157
Reach IV	465	443	7.8	F.P.	880	.035	.09	20	2:1	7.2	246	3.58	)
	443	378	6.3	F.P.	790	.04	.11	20	2:1	6.9	233	3.39	--76)
Reach V	378	329	4.2	F.P.	700	.045	.14						9.2 4/
	329	289	3.3	F.P.	640	.055	.17						0 3/
Reach IX	100	36	1.6	M.P.	223	.04	.09	6	2:1	5.6	95	2.35	26

1/ Watershed area excludes the controlled area
2/ Flood Prevention - F.P.; Flood Prevention & Drainage - M.P.
3/ Clearing, snagging & seeding only
4/ Clearing, snagging, shaping of banks & seeding

July 1964

TABLE 4 - ANNUAL COST
Twin-Rush Creek Watershed, Indiana

(Dollars) 1/

Evaluation Unit	Amortization of Installation Cost 2/	O & M Cost 3/	Total
Structures 1 through 3 and Channel Improvement Reaches I through V and Reach IX	90,640	44,440	135,080
TOTAL	90,640	44,440	135,080

1/ Price base 1963 for Installation Cost - Projected Long Term Cost for O & M.

2/ Amortized at 3% for 50 years.

3/ Includes O & M to maintain present capacity in reaches where no construction is planned.

July 1964

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS
Twin-Rush Creek Watershed, Indiana

(Dollars) 1/

Item	Estimated Average Annual Damage		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	44,130	4,700	39,430
Other Agricultural	4,726	485	4,241
Non-Agricultural			
Road and Bridge	7,490	135	7,355
Subtotal	56,346	5,320	51,026
Erosion (Flood Plain Scour)	2,209	782	1,427
Indirect	5,855	610	5,245
TOTAL	64,410	6,712	57,698

1/ Projected long term prices

July 1964

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Twin-Rush Creek Watershed, Indiana

(Dollars) 1/

Measure	AVERAGE ANNUAL BENEFITS									AVERAGE BENEFIT	
	Flood Prevention									Average Annual Cost	Benefit Cost Ratio
	Damage Reduction	Changed Land Use Agricult.	More Inten Use Cropland	Local Secondary	Inciden. Recreat.	Water Supply	Redeve-lopment	Drainage	Total Benefit		
Structures 1 through 3 & Channel Imp. Reach I through V & Reach IX	54,870 2/	5,705	10,232	13,460	6,000	124,500	13,190	1,129	229,086	135,080	1.7-1

1/ Price base 1963 for installation cost. Projected long term prices for benefits and O & M.

2/ In addition, land treatment will provide flood reduction benefits of $2,828.

July 1964

INVESTIGATIONS AND ANALYSES

Project Formulation

The purpose of this project is to reduce flood plain damages, increase farm income, and to serve as an important step in the broad economic development in the watershed and the surrounding area.

The Washington County Soil and Water Conservation District became a legal organization 18 years ago for the purpose of reducing soil erosion, water runoff, and improving land and farmer resource management. It was soon apparent in the hilly erosive area of this watershed, that land treatment measures alone would not bring about all the results desired. Although it was true that on site erosion and water runoff were partially controled, downstream flooding was not significantly reduced.

When the provisions of Public Law 566 became familiar to the sponsors and local residents, immediate interest developed. The nearby project in Elk Creek Watershed was closely followed from its inception to its completion. This project showed the possibilities of a solution to their problems and also hinted an answer to water supply and recreation needs. An application for assistance, under authority of P.L. 566, was submitted in November, 1961.

This plan represents the most desirable combination of measures that will provide adequate watershed protection, flood prevention, drainage, municipal water supply for the nearby City of Salem, and incidental public recreation.

Land Use and Land Treatment

Land use conversion needs and land treatment measure requirements were the subject of a careful study by the Washington County Soil and

Water Conservation District Supervisors and Soil Conservation Service technicians. The Washington County Conservation Needs Inventory provided much of the required information for the resource areas within the watershed. Combinations of land treatment measures and required land use conversions, which applied to each land capability unit, were determined.

The costs for the installation of these measures and the cost of the necessary technical assistance were then determined. A summary of these costs is shown in Table 1.

Hydraulic and Hydrologic Investigations

The watershed was analyzed using procedures outlined in the National Engineers Handbook, Hydrology Section 4. This analysis was used to develop physical data for the economic evaluation and design of proposed works of improvement.

Rainfall data were used for project evaluation since no U. S. Geological Survey stream gage was located within the watershed. The U. S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States," was chosen as the source of rainfall frequency information. The data from the rain gage located at Salem, Indiana, approximately six miles southeast of the watershed, has been integrated into the T.P. No. 40 frequency studies by the U. S. Weather Bureau.

The rainfall-runoff relationship was determined from a study of soils and soil cover. A tabulation of land use by land capability units was prepared by the Work Unit Conservationist, Soil Scientist and Hydrologist. The Soil Cover Complex numbers reflecting present conditions for individual structure sites and the entire watershed were prepared. The Soil Cover Complex number for the future condition for the entire watershed

was developed by assuming those land treatment measures installed during the installation period of the project. The U. S. Forest Service determined Soil Cover Complex numbers for the forest land.

The average runoff curve number for present watershed conditions was computed as 76 and for future conditions as 74.

The design runoff curve numbers for each structure were developed by evaluation of the watershed conditions contributing to each site. These curve numbers are considered accurate enough for final design. Runoff for the design frequency of the principal spillway was obtained from either the six hour duration rainfall values in T.P. 40, using antecedent moisture condition II$\frac{1}{2}$, or by the method set forth in SCS, T.R. 10, using antecedent moisture condition II.

The emergency spillway and freeboard design were based upon Soil Conservation Service criteria. The criteria, as established by Engineering Memorandum--Indiana No. 7, dated January 9, 1963, were adhered to for all hydrologic criteria. The spillway design data, along with other structural information, are shown in Table 3.

The channels of Twin Creek, Rush Creek, and Rinkers Creek were divided into nine hydraulic reaches. The economic problems and stream characteristics were considered in the selection of these reaches. Ten full valley and three channel cross-sections were surveyed to mean sea level datum. Stage versus discharge curves were prepared for each full valley cross-section. Manning's Open Channel Formula was used to determine the stage-discharge relationships for each valley and channel section.

Reach IX was designed as a multi-purpose ditch for drainage and to carry approximately a five year cropping season storm discharge. Incor-

porated in this design was the additional capacity required to handle the intercepted drain at the upper end of the reach. This intercepted drainage area, of approximately 1.05 square miles, has previously crossed the main flood plain and discharged into the upper end of Reach IV.

Synthetic triangular hydrographs were developed based on time of concentration using the procedure set forth in Milwaukee E & WP Hydrolocy Memo No. 4 for obtaining peak discharges. These hydrographs were routed and accumulated down the various tributaries and main channel evaluation reaches by the Wilson Method of flood routing. A six hour duration storm was used for damage appraisal.

The Wilson Method of flood routing was used in routing the 20, 10, and 3 year frequency storms expected to occur during the cropping season, April through November. These storms were routed through the evaluation reaches under present condition and future conditions with the proposed works of improvement of the project assumed to be in place. The routing of present condition, modified by land treatment and structures 1, 2, and 3, failed to provide the desired level of protection. It was finally determined by flood routings that a combination of land treatment, structures 1, 2, and 3, a channel designed to carry approximately the five year cropping season discharge in Reaches II, III, IV, V, and IX, and clearing and snagging in Reach I would give the desired level of protection to the agricultural flood plain. The effects of the works of improvement mentioned above would give between a three to five year level of protection.

The peak discharges at the foot of each routing reach was averaged with the peak discharge at the head of each routing reach to give an average peak discharge for the reach. This average peak discharge was

then applied at the foot of the reach. This procedure was used for the three frequency storms routed. To obtain the peak discharges for the remaining five frequency storms studied, the discharges of the three flood routed storms were plotted versus their respective runoff in inches. Then the desired discharge for the other frequency storms was interpolated from this curve by using the runoff in inches associated with each storm frequency. By the use of this procedure, stage-discharge relationships were provided to the Economist for the 100, 50, 25, 10, 5, 3, 2, and 1 frequency events.

Stage-area inundated curves were developed for each full valley cross-section. Then, by the use of the concordant flow principal, all the stage-area inundated curves for each full valley cross-section with an evaluation reach were combined and associated with one "control" section.

Using this "control" section, usually located near the foot of the reach, stage-area inundated tables, 0-2 feet depth and over 2 feet depth, were prepared for each evaluation reach. This information was then coordinated with stage-discharge and discharge-frequency curves.

Recurrent flooding during the growing season and the effects of backwater from the East Fork of the White River have been considered and included in this investigation. The Bedford, Indiana, U. S. Geological stream gage, located 17.9 miles downstream from the confluence of Twin Creek was used to compute the estimated annual and cropping season backwater conditions. The frequency stage relationships of these estimated backwater conditions was used as a basis for the beginning of channel design on Twin Creek.

For some storms the peak outflow from Twin-Rush Creek will be slightly

higher. However, any resulting increase in stage on the East Fork of White River would not be measurable.

Engineering Studies, Design, and Cost Estimates

The waterflow control studies included the proposed project and some variations. Twelve structure sites were considered including the three sites set forth in this plan.

Four of the sites considered, but not planned, are located above Structure No. 2. These sites would not provide the needed capacity for municipal water storage. Also, any combination of these four sites would provide less flood control and would cost more per acre-foot of flood storage than the planned site for Structure No. 2.

Three alternate sites were considered below Structure No. 3. None of these sites were used because of the large amount of road relocation involved, the relatively small increase in area controlled, the reduction of the area benefited, and increase in the cost of any of these sites over the planned location of Structure No. 3.

Two additional sites for floodwater retarding structures were considered. The more likely of these two sites was tested and proved impractical; therefore, neither of these sites were included in the plan.

The channel location was based on good design practice, topography of the flood plain, economics, and the desires of the local people.

Several alternate routes for various portions of the channel were studied to find the most practical route. The channel was considered supplementary to the structures.

The works of improvement, as set forth in this plan, were determined to be the most practical to achieve the objectives of the local organization.

The basic data used in structure evaluation and design was obtained from U. S. Geological Survey topographic maps, aerial photographs, field surveys, hand auger borings, and field observations. All preliminary designs and evaluations were made from a study of the U.S.G.S. topographic maps and field observations by the Planning Engineer and Geologist.

The storage and area flooded versus stage curves for the structures were developed from the U.S.G.S. topographic maps. Field surveys were made along the centerline of the fill of each site included in this work plan. This surveyed section was used to compute fill yardages and to check the accuracy of the topographic maps. A partial topographic survey was made of the emergency spillway areas of each site. These emergency spillway topographic maps, the U.S.G.S. maps, and hand auger borings were used in determining the size, elevation, and amount of excavation expected from the emergency spillways. All of the field surveys were based on sea level datum.

The structures are designed to meet the criteria contained in Engineering Memorandum-Indiana 7, Engineering Memorandum-SCS-27, and other applicable SCS engineering memoranda, and the minimum design standards of the Indiana Flood Control and Water Resources Commission.

The requirements for sediment storage, as determined by the Geologist, were used to set the elevation of the low stage inlet of each floodwater retarding structure. The calculated 50 year sediment yield was used for all structures. The elevation of the low stage inlet for Structure No. 2 was based on the total of the needed sediment storage and the needed municipal water supply storage.

The principal spillway conduit is the size which will give the most

economical design. Likewise, the crest elevation and size of the emergency spillway is based on this analysis. The crest elevation is, in each case, higher than that required by the criteria for minimum flood storage. The cost of fill, pipe, easements and rock excavation for various designs were studied to determine the best solution for each site.

The total runoff only was determined for the emergency inflow hydrograph. This runoff was converted to storage in the reservoirs to determine the approximate maximum water surface elevation.

The elevation of the top of the dam was set by flood routing the freeboard hydrograph. The inflow hydrographs were developed by the C.T.U. method given in section 3.21 of the Hydrology Guide. The flood routing was done by a mathematical method based on the principal that the incremental inflow minus the incremental outflow is equal to the change in storage, ($I-O = \triangle S$, page 3.17-1, Hydrology Guide). The time interval used was equal to the time interval used in the inflow hydrograph. This method has been compared with the graphical method on several existing flood routings and found to be at least as accurate as the graphical method. The capacity of each emergency spillway was determined by the procedure set forth in Technical Release No. 2 and Supplement A to T.R. No. 2.

A slide headgate and a pipe conduit are planned at the bottom of the drop inlet. The elevation of the conduit invert is planned so the most of the reservoir area can be drained. This feature will help to keep the borrow located in the reservoir dry. If the borrow material within the reservoir were flooded, more of the material would have to come from the adjacent ridge tops and the area below the dam. This

borrow would, in some cases, require longer hauls and more seeding. The installation of this outlet should increase the efficiency of construction and should, therefore, reduce the cost of construction.

The embankment and foundation design is based on the geological report, hand auger borings, and an analysis of sites with similar materials.

Structure No. 1 is planned with $2\frac{1}{2}$:1 side slopes on each side. The fill material will come from the emergency cut, flood plain and valley walls. The dam height, except the portions in the channel, is 37 feet. The foundation depth is five to ten feet to shale. With a core trench cut into shale and a foundation trench drain, this embankment design should provide a factor of safety of 1.25 or greater.

Structure No. 2 has similar materials to Structure No. 1 except with more sand and gravel in the flood plain material. The foundation depth is about ten feet to shale. The dam height is 58 feet above the flood plain. This dam will require a factor of safety of 1.5. A foundation trench drain is planned to intercept the layer of sand and gravel just over the shale. The core trench will be cut into the shale. Riprap is planned on the upstream slope from the high stage inlet to the toe of the embankment. A 3:1 slope upstream and a $2\frac{1}{2}$:1 slope downstream are the planned embankment side slopes. A ten foot berm is planned on each side of the embankment.

The foundation of Structure No. 3 is about five feet deep to shale, however, the embankment is about 73 feet high. Therefore, to provide a factor of safety of 1.5 for this structure, 3:1 side slopes will probably be necessary on both sides of the embankment. A ten foot berm is planned about halfway up the fill on each side. A positive cutoff to

shale is planned, as well as, a foundation trench drain. The fill material for this structure will come from the emergency cut, the flood plain and the ridge tops adjacent to the fill site. Due to the considerable variation in the properties of the three sources of borrow, the soil mechanics report may show that this should be a zoned fill; or that, at least, selective placement is necessary. The price per cubic yard of fill was raised in the cost estimate to allow for a zoned fill and to cover the cost of bringing borrow down the steep hillside from the ridge top. The use of a zoned fill will probably allow steeper side slopes than would the use of a fill constructed entirely of the clay from the ridge tops.

The Water Supply Report of Fraps and Associates, Inc., Consulting Engineers, to the City of Salem, indicates that Structure No. 2, refered to as the Rinkers Creek Site in the Report, is one of two practical sites for the Salem water supply. The Report indicates that the firm considered several sites. The Report also indicates that, to supply three MGPD, the required storage would be 3,020 acre-feet. The specific costs and measures included in the project were taken from the Report.

The clearing estimates are based on aerial photographs and U.S.G.S. topographic maps. The area planned to be cleared is the woods below the elevation of the high stage inlet of each site. All areas above the normal waterline where the sod has been removed will be seeded. Also, all of the fill above the waterline, not covered by rip-rap, will be seeded.

The easement area includes the surface area at the elevation of the emergency spillway for all sites. This elevation is higher than the

maximum water surface for the emergency hydrograph in the class a and b structures, Nos. 1 and 2. The value of the land per acre and the value of improvements was determined by the local people. The easement costs were determined by adding (1) the value of all improvements, (2) the value of the land needed for the dam site, the emergency spillway, borrow and permanent pool, and (3) one-half the value of the land in the flood pool.

The installation services for each structure was based on a percentage of the construction cost excluding rock excavation. The percentage used was based on the complexity of design and comparative construction cost. For structures 1, 2, and 3, respectively, this percentage was 30%, 20%, and 25%. The installation services for channel improvement is computed at 30% of the construction cost.

The annual operation and maintenance cost is taken from drawing SCS 3-L-46170. Sheet number 1 was used for the structures. Curve No. 2 on sheet No. 2 was used for channels.

The channel design and estimates are based on field surveys, U.S.G.S. topographic maps, aerial photographs, and field observation. The full valley and channel cross-sections used by the Hydrologist, were used to determine the bank full elevation and the grades of the designed channel. The bridges were measured to determine the span and amount of obstruction to the channel flow.

The channel was designed based on the assumption of normal flow. The hydraulic grade line was established from the backwater elevation at the outlet. The slope of the hydraulic grade line was established to be below the low ground elevation shortly below the upper end of Reach II.

The channel is designed with the bottom grade parallel to the hydraulic grade line for each design flow. Therefore, the assumption of normal flow is valid.

The head loss at the more restricting of the two bridges, which will remain in place, was computed and found to be less than 0.1 foot; therefore, the head loss for both bridges was negligible.

The alignment of the channel in Reaches II, III, and lower part of IV generally follows the existing channel. The curves in the new channel will generally be 500 foot radius or longer. A curve in Reach II near the lower end will have a 310 foot radius, and one just below cross-section No. 1 will have a 200 foot radius. The two curves are left relatively sharp to avoid a longer cut through a high bank.

The quantities of excavation were based on the surveyed sections, stereoscopic study of aerial photographs, and field observations. The quantities of clearing were determined from aerial photographs. The location of approximately 50 appurtenances were determined from the topographic maps and aerial photographs and included in the cost estimates. The side slopes of the channel, the berm and the inside slope of the spoil will be seeded. At locations where the spoil is stacked with a steep slope on both sides, the entire spoil bank will be seeded.

Land values were furnished by the local people as described for structures. The easement costs were determined by using the full value of the land permanently needed. The approximate value of the loss of the use of the land for one year was used on land needed during construction.

Geological, Sedimentation and Erosion Investigations

Each of the three proposed dam sites were investigated. These

investigations were accomplished by means of observation of rock exposures, stream bank profiles, channel bottoms and general site characteristics. Hand auger borings and probings provided general information regarding overburden. In the watershed a somewhat cavernous limestone caps the ridges and is found exposed part way down the valley slopes. Below this limestone is a dense gray siltstone with occasional sandstone ledges, and, rarely, a limestone layer. All of the sites are so located that the abutments and the foundations are of this shale under varying amounts and kinds of overburden.

The valley walls are steep and have shallow mantles of residual overburden. Where more satisfactory emergency spillway sites do not exist, rock excavation will be necessary. The lower valley walls, particularly on the north or east side of the sites, is usually more gently sloping and the overburden is deeper--consisting of colluvial silts and sands. The flood plains contain alluvial silts underlain by about from 5 to 10 feet of valley fill deposited when the streams were blocked by glacial dams.

Form SCS-375, "Preliminary Geologic Investigation of Dam Sites," which includes all pertinent information, has been prepared for each of the proposed sites.

All sites appear to be feasible from a geologic standpoint, and no adverse conditions were noted. A private engineering firm was employed by the City of Salem to consider suitability of water supply site locations. This firm concurs in the decision that the location for Structure No. 2 is suitable for the multi-purpose use proposed.

Channel improvement works include some deepening, some widening and

minor relocation. Flood plain overburden, in which this work will be done, has been examined by hand auger borings and channel bank observations. Similar work accomplished on the nearby Elk Creek Watershed, now in operation, provided useful design data.

Detailed investigation of structural works of improvement will be accomplished prior to final design.

Sediment storage design data was computed for each of the three structure sites. Land use and land treatment information, both present and planned, was used for erosion computations. Employing Universal Soil Loss equation procedures, cropland soil losses were estimated. Sheet erosion losses from other land use acreages were estimated on consultation with the Work Unit Conservationist, the Soil Scientist, and the State Forester. Other types of erosion such as gully, stream bank, road side, scour and stream bed sources, were estimated after observation of watershed conditions and consultations with local residents. Sediment storage estimates, adequate for final design, were recorded on SCS form #309, "Reservoir Sedimentation Design Summary," for each site.

Flood plain sediment and erosion damages were studied in the field, along surveyed full valley cross-sections or ranges. Additional ranges were added in reaches that were too short to warrant at least three cross-sections for hydrologic purposes. Hand auger borings, observations of soil removal or accumulation at fences, trees and roadways, and discussions with local residents provided information of amount and type of damage. The data gathered in this study indicated that flood plain scour is the only significant form of land damage warranting evaluation. The data collected was expanded to show location, extent of damage and the stage

at which it occured in each reach. The Party Economist then evaluated this information to determine damage and damage reduction values. Scour damage amounts to an estimated weighted 41% on 5.0 acres each year.

Economic Investigations

The basic information for agricultural type damages was obtained from personal interviews and questionnaires circulated to all the farmers within the flood plain. Approximately 95% of the farmers and farm operators were contacted to obtain information on crop production, crop damage and land use with the aid and cooperation of the local sponsoring organization. Non-agricultural damages were obtained from highway and public utilities officials, and others connected with maintenance of these facilities.

All cost and prices used were based on 1963 price level. All damages, benefits, and operation and maintenance costs were converted to long term prices using "Agricultural Price and Cost Projections," September, 1957, published by the U. S. Department of Agriculture. Farm operation costs were based on custom rates charged for power operated farm machinery, and other costs; such as seed, fertilizer, and labor, were obtained locally and converted to projected long-term prices.

A 3% interest rate was used for discounting future benefits and in converting public and private investment eligible for Federal loans to an annual basis. A 5% rate was used in converting associated on-farm costs to annual basis. Evaluation of all project benefits were based on a 50 year period.

Land easement and rights-of-way costs estimated were arrived at by (1) measuring the area involved by each floodwater retarding structure as

plotted on topographic maps; (2) estimating the area needed for channel improvement; (3) determining the per acre cost of the land involved as estimated by the local sponsors in consultation with the Service. These values were checked against the average net production per acre for this land under present conditions and use. There was little or no difference between this and the amortized acre cost that is included in the installation cost as land easements and rights-of-way.

Floodwater damages and benefits were computed using the frequency method as described in Chapter 3 of the Economic Guide, Soil Conservation Service. Separate damage frequency curves were developed for each reach and each type of damage using the stage frequency data provided in the hydrologic study.

The procedure used for intensive study of crop and pasture damage is based upon the damage resulting from the largest flood in each year, with a 20% adjustment factor to convert to the most damaging flood each year. A 15% factor is added for recurrent damages from duplicate flooding of bottomlands.

Full valley cross-sections which were combined into damage reaches (also hydrologic reaches) were used in determining the acres flooded by depth increments of 0-2 and over 2 feet. Information from farmer interviews and general inspection relative to land use, yields, and cropping pattern for the flood plain land were used in developing appropriate evaluations. Two different composite acres were adequate for evaluation of all flood plain reaches--one for Reach IV and a different one for all other reaches.

Flood damage factors for each month and for two depth categories,

0-2 and over 2 feet, were determined for each crop. Damage schedules were developed, by months, for the different crops and weighted by the percent of monthly rainfall distribution. An average annual damageable figure per acre for the two depth categories was computed for the composite acre.

The composite acres and flood free yields used are as follows:

Without Project	Crop	Yield/Acre	Percent
Reaches II, III, V, VI, VII, VIII	Corn	90 bu.	53.6
	Soybeans	25 bu.	36.4
	Wheat	30 bu.	1.0
	Perm. Past.	75 C.P.D.	1.0
	Woods		7.0
	Other		1.0
Without Project			
Reach IV	Corn	90 bu.	28.8
	Soybeans	25 bu.	19.2
	Woods	-	52.0

The average annual damageable figure per acre, based on the above composite acres for depth 0-2 feet and over 2 feet, was used to develop a stage damage curve for each reach. From peak discharge-frequency relationship, a flood damage versus frequency of occurrence graph was made. The average annual crop and pasture damage for each reach was then determined by planimetering the area under the curve and converting to dollar damage according to the scale of the graph.

The average annual benefit, by reaches, due to works of improvement, was determined by subtracting the remaining damages with the works of

improvement from the damage evaluated without the measures.

Other agricultural damage value per acre was determined from interview information. The amount of money spent for the removal of debris and fence repair was related to the area flooded for three frequency size floods; large (25 to 50 year flood); medium (10-15 year flood); and small (annual or two-year flood). The area flooded by each of these floods was available from crop and pasture damage studies for each reach.

The average annual damage and benefit for each reach was determined from its respective damage versus frequency curve as explained above for crop and pasture.

Non-agricultural damages to roads and bridges were obtained from highway officials and maintenance crews as to the amount of damage at different depths and sizes of flood. Using information from the Hydrologist, as determined from cross-sections of the channel, bridge section, and road profile, the damage versus stage graph was drawn for each bridge crossing subject to floodwater damages. The monetary value of damages due to a large flood--25 to 50 year, medium size flood--10 to 15 year, and the stage at which damage begins was obtained for each damage site in a reach. A damage versus frequency curve was developed. The stage and frequency at which no flood damage occurs and the frequency and stage of the medium and large size floods was determined by the Hydrologist based on cross-sectional data at the site where damage occurs.

The monetary value of the average annual damage to roads and bridges was obtained by use of the damage versus frequency curve for with and without the proposed works of improvement. Average annual benefit was derived by subtracting the remaining damages from the damage evaluated

without the measure.

Estimates of erosion damage in the way of flood plain scour were developed by, (1) composite acre value of land being damaged, (2) annual increment of damage, (3) percent reduction in productivity, and (4) expected recovery. The formula used for converting to monetary terms is outlined in the Engineering and Watershed Planning Unit October 1954 Training Outline, Flood Plain Scour, III-A-2-c-(4), page 118. The reduction of damage was computed as 100% reduction on that part of the flood plain no longer flooding after installation of project.

Indirect damages were estimated to be ten percent of the total agricultural and non-agricultural damage.

Cost Allocation

Structure #2 - Flood Prevention and Municipal Water

Use of Facilities Method

Storage	Capacity Ac-Ft.	Capacity By Purpose	
		Flood Prevention	Municipal Water
For Sediment	167	167	
For Municipal Water	3,020		3,020
For Flood Prevention	2,433	2,433	
Total	5,620	2,600	3,020
Percentage	100%	46.3%	53.7%

Reach IX Flood Prevention and Drainage Channel

Second Alternative

Floodwater damage reduction benefits alone	$1,183
Total joint benefits to F.P. and Drainage	2,258
Assumed joint benefits to Flood Prevention	50%
Assumed joint benefits to Drainage	50%

F.P. Benefit	Joint Benefit	Drainage Benefit	Total Benefit
1,183	2,258		3,441
1,129		1,129	
2,312 (67.2%)		1,129 (32.8%)	3,441

Determination of Annual Benefits from Changed Land Use and More Intensive Use of Present Cropland

Benefits due to more intensive use of present cropland within the flood plain were determined from basic data obtained from farmer interviews and professional agricultural leaders. This information was used to determine the level of production expected with adequate internal drainage, a stable water table and a moderately high level of fertility and management program that could be expected with the level of protection proposed by this project.

In determining the number of acres that will be farmed at a more intensive use due to reduced flooding, a tabular form was used showing the number of acres flooded at average of 2-year and 5-year frequencies for "without project" and "with project" conditions. This represents the range (3 to 5 year) protection generally required to bring about fertility practices and management that will result in added income from more

intensive use of present cropland. The proposed measures will reduce the frequency of flooding on 1,251 acres on which a more intensive use benefit will be derived. Changed land benefits in Reach IV were estimated on 170 acres with 80% participation or a total of 130 acres of woodland that will be cleared for cropland as determined by interview.

All production type benefits were determined by (1) the expected participation, (2) future net income, (3) deducting all associated costs, (4) discounting for lag in accrual, and (5) deducting future flood damage to a higher damageable crop.

Secondary benefits were evaluated on the following basis: (1) value of local secondary benefits stemming from the project were considered to equal 10% of the direct primary benefits, (2) secondary benefits induced by the project were considered to equal 10% of the increased cost incurred in connection with increased production.

Incidental recreation benefits to the flood prevention and municipal water supply Structure No. 2 were determined on the basis of visitor-day of use. Information as to the estimated visitor-days of use was furnished by the City of Salem and checked by interviews of operators of similar, existing recreational facilities in the local area. The total estimated visitor-day of use to this structure is 15,000 annually. A value of 50¢ per visitor-day was used. The total net incidental recreational benefit is estimated at $6,000. This benefit is evaluated on the water impoundment with boat facilities only. The addition of facilities that will be installed later, will increase the potential benefits to this impoundment.

Water supply benefits to the proposed municipal water storage in Structure No. 2 estimated by Fraps and Associates, Inc., Consulting

Engineers, Indianapolis, Indiana, was based on potential growth and industrial expansion to the City of Salem.

Evaluation of redevelopment benefits, resulting from income provided to the unemployed and under-employed labor of the area is based on labor used in construction, O & M, and other services created by the project measures. As indicated by Fraps and Associates, the location of an additional water supply source in the Twin-Rush Watershed could "open up" areas northwest of the city to industrial and residential construction as a result of availability of water.

Supporting Data - More Intensive Use of Present Cropland

All Reaches

Without Project

Land Use	Acres	Flood Free Yield	Gross Value (Dollars)	Production Cost (Dollars)	Net Return (Dollars)
Corn	690	90 bu.	86,319	35,500	50,819
Soybeans	541	25 bu.	31,108	11,934	19,174
Wheat	10	30 bu.	465	282	183
Total	1,251		117,892	47,716	70,176

With Project

Corn	690	105 bu.	100,705	40,565	60,140
Soybeans	541	30 bu.	37,329	12,335	24,994
Wheat	10	35 bu.	542	295	247
Total	1,251		138,576	53,195	85,381
				Net difference	15,205

Less associated cost:

215 acs. x 500 ft/ac. = 107,500 @ 0.28 x 0.05478 1/	=	1,649
10,000 ft. main & laterals @ 0.45 x 0.05478	=	246
12,450 ft. surface dr. @ 0.30 x 0.05478	=	205
damage to higher damageable value - 2.20 x 1251	=	2,752
Net Benefit		10,353
Allocated to joint benefit in R. IV		244

1/ Amortization factor 50 years 5%

Supporting Data - Changed Land Use Benefits

Reach IV

Without Project

(170 Acres Woods - 80% Participation - 130 Acres)

Land Use	Acres	Flood Free Yield	Gross Value (Dollars)	Production Cost (Dollars)	Net Return (Dollars)
Woods	170	-	-	-	0
Total	170				0

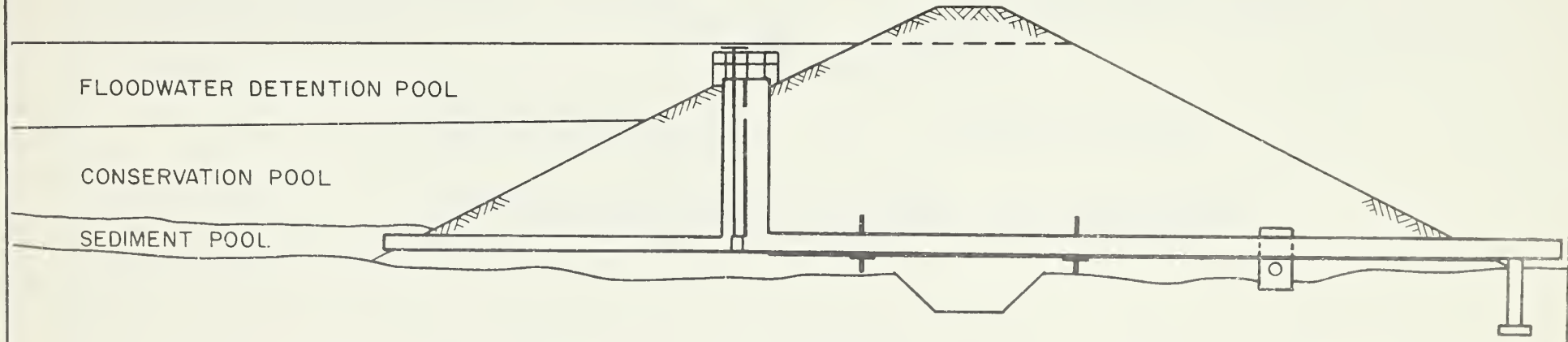
With Project

Corn	85	105	12,405	4,997	7,408
Soybeans	45	32	3,312	1,040	2,272
Woods	40				
Total	170		15,717	6,037	9,680
				Net difference	9,680

Less associated costs:

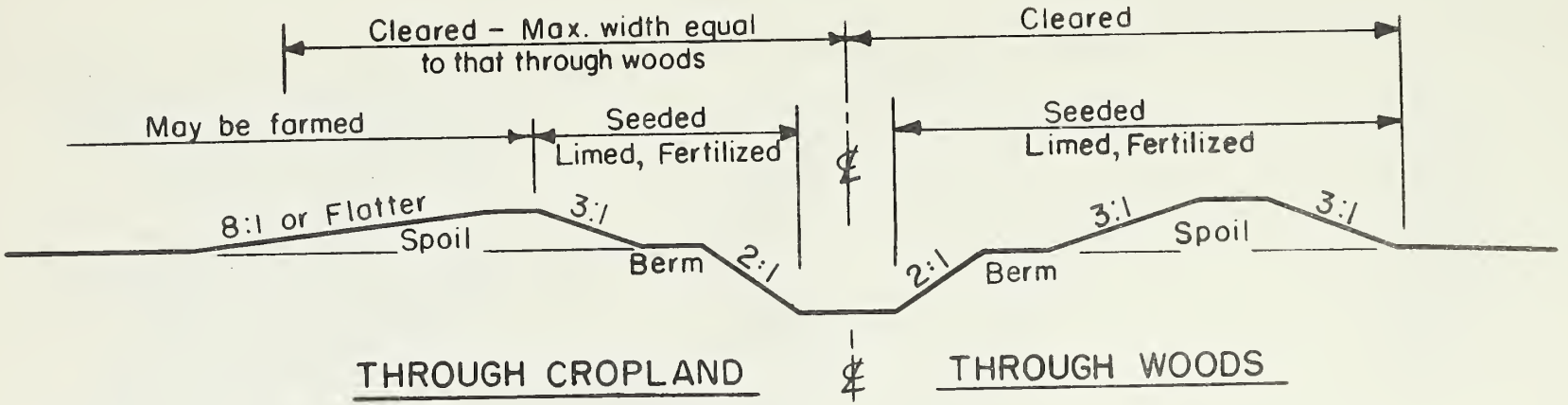
Clearing 130 acs. @ $150 x 0.05478 1/	=	1,068
Tile 130 acs. x 500 ft/ac. @ 0.28 x 0.05478	=	998
Surface dr. 5000 ft. x 0.30 x 0.05478	=	82
Mains & laterals 3,610 x 0.45 x 0.05478	=	89
Damage to higher damageable value (2.25)	=	731
Net Benefit		6,712
Joint Benefit(30%)		2,014

1/ Amortization factor 50 years 5%

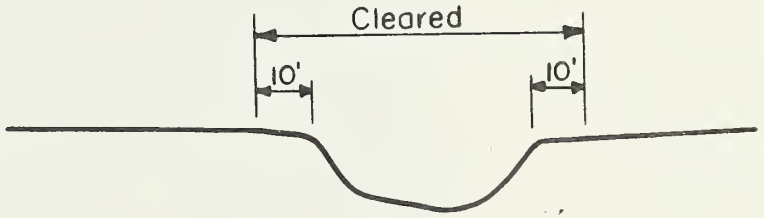


SECTION OF A TYPICAL
MULTIPLE PURPOSE STRUCTURE

Figure 1



TYPICAL SECTION – CHANNEL ENLARGEMENT



TYPICAL SECTION - CLEARING AND SNAGGING

Figure 2

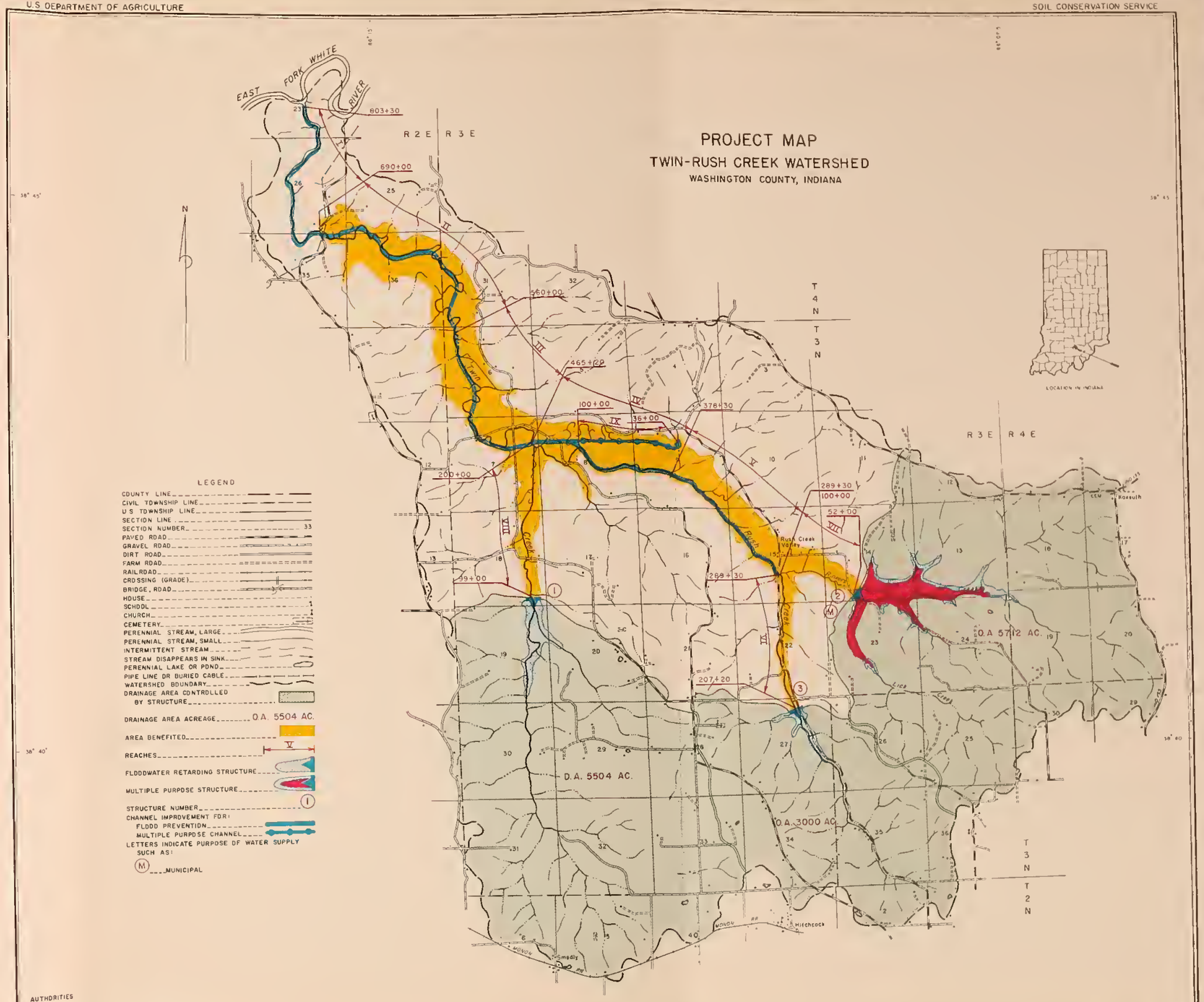
U.S DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

PROJECT MAP

TWIN-RUSH CREEK WATERSHED

WASHINGTON COUNTY, INDIANA



LOCATION IN INDIANA

LEGEND

- COUNTY LINE
- CIVIL TOWNSHIP LINE
- U S TOWNSHIP LINE
- SECTION LINE
- SECTION NUMBER 33
- PAVED RDAD
- GRAVEL RDAD
- DIRT ROAD
- FARM RDAD
- RAILRDAD
- CRDSSING (GRADE)
- BRIDGE, RDAD
- HDUSE
- SCHDOL
- CHURCH
- CEMETERY
- PERENNIAL STREAM, LARGE
- PERENNIAL STREAM, SMALL
- INTERMITTENT STREAM
- STREAM DISAPPEARS IN SINK
- PERENNIAL LAKE OR PDND
- PIPE LINE OR BURIED CABLE
- WATERSHED BDUNDARY
- DRAINAGE AREA CONTRDLLED BY STRUCTURE
- DRAINAGE AREA ACREAGE D.A. 5504 AC.
- AREA BENEFITED
- REACHES V
- FLDDDWATER RETARDING STRUCTURE
- MULTIPLE PURPDSE STRUCTURE
- STRUCTURE NUMBER (1)
- CHANNEL IMPRDVEMENT FDR: FLDDD PREVENTION; MULTIPLE PURPDSE CHANNEL
- LETTERS INDICATE PURPDSE DF WATER SUPPLY SUCH AS: (M) MUNICIPAL

AUTHORITIES

Prepared by the SCS Cartographic Unit, Milwaukee, Wisconsin, from USGS quadrangles Campbellsburg (1957), Salem (1953), Medora (1959), Smedley (1951), and Tunnelton (1958), and from the 1958 General Highway Map of Washington County.

6-3-64

APPENDIX

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

WORK PLAN FOR FORESTRY PROGRAM

ON

TWIN-RUSH CREEK WATERSHED

WASHINGTON COUNTY, INDIANA

UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

WORK PLAN FOR FORESTRY PROGRAM

ON

TWIN-RUSH CREEK WATERSHED

WASHINGTON COUNTY, INDIANA

APRIL 1964

I. Introduction

This work plan for the Forestry Program of the Twin-Rush Creek Watershed describes the procedures used in developing the data and lists the forestry measures that will contribute to watershed protection and flood prevention.

II. Procedure

Woodland areas are based on USGS large scale quadrangles of recent date, adjusted for latest changes in land use.

A cruise was designed establishing 30 study plots using random sampling techniques. One hundred eighty observations of hydrologic condition factors were made on these plots.

Timber types, conditions and volumes were observed and determined for each plot. Past treatment and management needs were recorded. The data was summarized, analyzed and developed through standard calculations into the program that follows.

Preliminary participation estimates of forest land treatment measures which may be attained during the installation period were arrived at in consultation with the District Forester for District VIII

and with the Work Unit Conservationist assisting the Washington County Soil and Water Conservation District. Final decision on measures and the amounts to be included in the work plan will eventually be determined in consultation with the watershed sponsoring organizations.

III. Woodland Condition Summary

Woodlands cover approximately fifty percent of the watershed and are located mostly on the steeper hillsides. Slopes from thirty to over fifty percent are common. Hardwood species, particularly oak, predominate. The following tables are indicative of present woodland conditions:

Stocking	Acres	Percent
Well Stocked	2,300	17
Moderately Stocked	6,440	47
Poorly Stocked	5,060	36
Total	13,800	100

Merchantable Volume (Average Net MBF/Acre)	Acres	Percent
0-2	13,800	100
3-5	-	-
6+	-	-
Total	13,800	100

Cutting History 0-10 years past	Acres	Percent
Little or None	10,580	77
Moderate	1,840	13
Severe	1,380	10
Total	13,800	100

Grazing Damage 0-10 years past	Acres	Percent
None	11,685	85
Light	846	6
Moderate	423	3
Severe	846	6
Total	13,800	100

Twin-Rush Creek Watershed was almost entirely wooded when white settlers arrived about 150 years ago. The level land was cleared for farming. This was followed by the usual pattern of cutting the best trees from established woodlands, permitting uncontrolled burning and heavy grazing by domestic animals. Uncontrolled burning has virtually stopped. Many farmers are now keeping cattle out of their woodlands.

Few woodland areas exist with sufficient timber volume for an operable cut. Some areas have been logged within the last five years and on these, also, the better trees and species were selected. Those of little demand, such as hickory, oftentimes were left.

Agricultural practices have been changing with the years. Now, some of the rural population on the watershed derives a part of its income from sources other than from the farm. Pasture land of poor quality is being abandoned and cropland which provides little income is reverting to pasture. Hardwoods are seeding in gradually and reclaiming some of these areas, although the process is exceedingly slow. Unfortunately, the more desirable species usually are not the first to come in, although if the area is protected and managed, they will come in in time.

Twin-Rush Creek Watershed is located in Cooperative Forest Management District No. VIII with headquarters at Scottsburg, Indiana. The District Forester assigned is in the Division of Forestry of the Indiana Department of Conservation.

Woodland fires, which once were common, have been virtually eliminated. Fire protection is directed by the Indiana Department

of Conservation, cooperating with local fire departments and rural residents.

While most woodlands were once pastured to some degree, conditions have changed during the past thirty years. Cattle now use no more than an estimated 15 percent of the woodlands and this will be further reduced through the watershed program. Where fencing is necessary to keep cattle out of woodlands a high degree of interest by operators has been indicated. It is anticipated that applied fencing will eliminate more cattle from woodlands through assistance of ACP measures.

Up to 50 percent of the woodland, especially on north and east slopes, will benefit to some extent from sanitation measures. Due to understocking in many stands this work falls in the light category except where openings can be made to incourage natural reproduction of the more desirable species. Program needs reflect the most desirable categories of cultural work needs. As most farm operations are conducted singlehanded and the farmer also works away from home in some instances, it is difficult to interest many in doing stand improvement except through Consulting Foresters. However, one way to accomplish cultural work is to train a small number of qualified persons who are interested in part-time or seasonal work and have them work from farm to farm under the technical direction of the forester. This also may not be successful unless enough jobs are available to keep these persons employed. This type of work is dependent upon ACP funds available on the watershed and the willingness of the county committee to approve ACP requests

for forestry cost-sharing.

Interest in tree planting has risen steadily in recent years. Most of the work is being done through contract with a Consulting Forester and is supervised by the District Forester.

IV. Multi-Purpose Needs and Possibilities

Of the three structures being seriously considered, one is being planned for multi-purpose use. Its location on Rinker's Creek in Section 14, T. 3 N., R. 3 E. has been tentatively selected. Its capacity, 3,020 acre-feet, is scheduled to supply Salem, Indiana with 3,000,000 gallons of water per day. The establishment of this Structure No. 2 will offer excellent possibilities for recreational development in that general area.

On Twin-Rush Creek Watershed, and particularly above structures which provide a municipal water supply, soil erosion and serious damage to water quality can be prevented by careful planning and by carefully supervised logging operations. Skidroad distance should be held to the minimum necessary to harvest the product, and the tractor should be kept on the skidroad. Roads must be kept away from the stream and above all there should be no skidding in the stream channel itself. Skidroad grades should be kept low regardless of the natural slope of the land; a maximum grade of 10 percent is preferred. The road should be planned with frequent dips or water bars to prevent a build up of flow over long, uninterrupted sections.

Damage usually occurs most severely during the actual logging operation. Therefore, it is advisable that the logging job is

completed as quickly as possible, the drainage ways put in order, the area is protected from fire and grazing, and nature is permitted to start recovery.

A few locations have recreational development possibilities. Fingers of streams in the upper reaches flow down a series of flat limestone stairsteps. Through careful planning and management under the P.L. 566 program, the water in these streams can be made clearer and to flow more steadily. This should improve conditions for more fish establishment. Under planned woodland management, wildlife should also find more favorable conditions to develop and multiply.

The accelerated land treatment of woodlands planned for this watershed also should be particularly effective in extending the useful life of structures.

V. Needed Forestry Program for Watershed Protection

The total need for each practice under the forestry program reflects the present condition of the woodlands. To achieve maximum improvement of the hydrology of the woodland soils, it would be necessary to accomplish the entire needed job. During the 5 year installation period a portion of this total need will be achieved. This 5 year goal is the immediate objective.

The total needs for forestry include:

Practice	Acres*	Percent of Total Woodland
Fire Control Intensification	All, continuing program	
Livestock Exclusion	2,115	15
Improved Forestry Practices	10,575	77
Sustained Yield Practices	1,880	14
Cultural Practices	6,345	46
Forestation	1,200	9

*Some areas need a combination of these practices while other areas need none. A total of these columns shows total acres of treatment only.

WOODLAND IMPROVEMENT MEASURES

The following described forestry measures are those recommended for use on P.L. 566 watershed work projects in the North Central Region. The primary purpose of these measures is to improve and maintain the hydrologic condition of watershed woodlands. Installation of forestry measures will simultaneously result in improvement of the timber stand and enhancement of other basic values which are inherent in a well-managed forest. Additional measures may be prescribed and recommended to correct unusual situations on some projects.

Livestock Exclusion (L)

This measure consists of excluding all farm livestock permanently from woodlands. Fencing all or a part of the woodland may be required. Livestock exclusion also may be accomplished by a permanent change in use of agricultural land adjoining the woodland.

Grazing by livestock has a serious damaging effect on the hydrologic condition of a woodland. The litter and humus layers are destroyed or compacted and this greatly reduces their ability to absorb water and to hold it. As a consequence, the amount of runoff is increased. Grazing also destroys young growth and reduces the density of the stand, thus it impairs the development and replenishment of litter and humus. Damage to both the young growth and mature trees reduces the productivity of the woodland and the quality of its forest products.

Technical assistance is needed to point out to woodland owners the harmful effects of woodland grazing from the standpoint of low

forage yield. Damages to woodland which result in poor hydrologic condition and reduction of other values are emphasized. A plan is needed to guide the owner in correcting these abuses.

Improved Forestry Practices (M)

This measure is aimed at improving woodland conditions and securing adequate stocking of desired species and mixed age classes. Stability, sound resource use, and long-term considerations are involved. Adequate woodland management plans are a necessity.

The Forest Management Plan recognizes, defines, and schedules fire protection, livestock exclusion, insect and disease protection, species selection, stand composition, thinning, cultural and sanitation work, needed tree planting and interplanting, harvest cutting and other factors. Forest values for watershed protection, wildlife cover, recreation and other selected uses are all considered when the plan is prepared.

Technical forestry assistance is necessary for:

1. Conducting meetings in cooperation with other agencies and making contacts which are necessary for the purpose of educating and motivating woodland owners and operators.
2. Examination of woodlands to obtain stand and growth data and other information needed for preparation of maps and plans.
3. Preparing the Forest Management Plan in consultation with the owner and discussing with him in the woods all phases of this plan.

The Forest Management Plan, when implemented, will insure the improvement and maintenance of the hydrologic condition. An

appreciable improvement in water quality and storage capacity will result. Timber production will also be increased.

Sustained Yield Practices (H)

This measure includes accomplishment of many of the practices scheduled in the Forest Management Plan as these relate to sustained yield management. They include:

1. Boundary marking, estimating and planning for sale and removal timber.
2. Marking timber for harvest, locating logging roads, skid trails, landings and other clearings.
3. Marketing and contract preparation assistance.
4. Inspecting an operation while in progress and after its completion. The timber stand, of course, will be managed to maintain the proper stocking level.

Technical assistance is necessary to plan and conduct the above operation with the landowner with the least possible disturbance to the existing hydrologic condition. Thereafter an improvement of the hydrologic condition of the area will occur.

Cultural Practices (C)

This practice consists of the conventional timber stand improvement measures and reinforcement planting, with special emphasis on improving the hydrologic condition of the woodland. Diseased, defective, poorly formed and otherwise undesirable trees are eliminated from the stand by cutting, treating with herbicides, or girdling to improve species composition, stand density and rate of growth. At the same time it is important to maintain the proper level of

stocking.

Timber stand improvement when properly applied will increase yields and produce higher quality products. It will help to insure that the land will remain in woodland, be managed and protected, thus contributing needed hydrologic benefits.

The stand conversion practice consists of planting trees in openings of thinly stocked woodlands to bring them to the proper stocking level and to improve their composition and hydrologic characteristics. A fully stocked stand of desirable tree species is the objective.

Technical assistance is needed to determine the treatment to apply, methods to use, marking of trees in the stand, selection of tree species to plant, and checking work which has been performed under this practice.

Forestation (P)

This measure consists of planting suitable species of trees on open land for the establishment of a forest stand. Planting is recommended for land better suited to woodland than to agriculture, that is, land with steep topography, depleted fertility, presence of rocks, brush, erosion, or other factors.

The purpose of the measure is to improve hydrologic condition by the establishment of a forest cover, and achieve better land use. This will build up litter and humus and create conditions which will contribute to better infiltration, retention and detention capacity, reduced runoff and soil stabilization.

Technical assistance is needed to help the landowner select

the area to plant and species and methods to use in planting, to schedule planting equipment, to give assistance during the planting operation, and to check complete projects.

VI. Planned Program for Watershed Protection

The following table shows need and expected participation and accomplishment during the five-year installation period. These estimates presuppose that adequate technical assistance will be available to build and carry through an accelerated program and that a high level of cooperation will be shown by local groups and assisting agencies.

Forestry Practices	Symbol	Needed Program (Acres)	Estimated Participation (Percent)	Planned Program (5 Yrs) (Acres)	Est. Accom. By Going Project (5 Yrs.) (Acres)	Balance for Watershed Project (5 Yrs.) (Acres)
		(1)	(2)	(3)	(4)	(5)
Livestock Exclusion	(L)	2,115	76	1,600	100	1,500
Improved Forestry	(M)	10,575	35	3,700	100	3,600
Sustained Yield	(H)	1,880	50	940	50	890
Cultural Practices	(C)	6,345	16	1,000	-	1,000
Forestation	(P)	1,200	80	960	50	910

Column (1) total is based on needs as determined by field observations. Columns (2), (3), and (4) indicate amounts for individual practices

determined through consultations with the SCS Work Unit Conservationist and the District Forester of the Division of Forestry and reflects their knowledge of what they can expect from the landowners in the watershed.

Column (5) total shows the accomplishment planned for the five-year installation period by the accelerated P.L. 566 program.

VII. Hydrologic Significance

Soils in the forested area are predominantly in hydrologic soil group C which is that group having slow infiltration properties after presaturation.

Present hydrologic condition class is 3.2 with a corresponding runoff/precipitation curve No. of 73. This indicates an average or fair hydrologic condition.

Installation of the measures programmed above will bring the average future hydrologic condition during the next 50 years to a class of 3.6 with a corresponding runoff/precipitation curve No. of 68. This represents a substantial improvement in hydrologic condition.

VIII. Cost of Program Installation

Work cost estimates are based on State and local averages for similar work, with adjustments for an accelerated program.

Practices to be Applied			Estimated Costs				
Practice	Area		P.L. 566 Tech. Assistance		Other Costs - Technical Assistance & Installation		Total Costs
	Non-Fed. Acres	Fed. Acres	Non-Fed. Land $	Fed. Land $	Cost $ per Acre	Non-Fed. Land $	Fed. Land $
L	1,600				4.00	6,400	6,400
M	3,700				1.00	3,700	3,700
H	940				1.00	940	940
C	1,000				20.00	20,000	20,000
P	960				35.00	33,600	33,600
Technical Assist-ance						6,470 1/	6,470
			14,030 2/		3.33 4/	13,245 3/	27,275
Total	8,200 5/		14,030			84,355	98,385

1/ Technical assistance costs of State and Federal Cooperative Forest Management going program.

2/ Federal P.L. 566 technical assistance funds available to match State funds. Includes 25 percent for overhead.

3/ State technical assistance funds to use in matching Federal P.L. 566 funds. Includes 18 percent increase for overhead.

4/ Average technical assistance cost per acre.

5/ Total acres of practices programmed.

Cooperative Watershed Management Branch
Division of State and Private Forestry
U. S. Forest Service
North Central Region

April, 1964